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SOUTH AMERICAN REFRIGERATION PLANT

Arrangement of Ammonia System and Use of After-Cooler for Economy; Gravity Circulation of Cold Air Through Refrigerating Rooms

WHILE Chicago may be the center of the packing industry for the North American continent, it is not the only large center of the western hemisphere, and Buenos Aires in the southern division has establishments ranking well with our own as to size and efficiency. The company handling this business uses, of necessity, refrigeration plants for meat storage, 3 being installed at Buenos Aires, Bahia, Blanca and Montevideo, in regard to which Engineering of London gives the following data:

That at Buenos Aires, called La Negra, cares for 800 oxen and 3000 sheep daily and has 7 freezing plants with 16 refrigerating rooms and 37 cold storage rooms, the total power needed being indicated by the boiler capacity, 2800 hp.

At Bahia is the Cuatreros plant with capacity of 200 oxen and 2500 sheep daily, having refrigerating installation as shown in Fig. 1. Refrigeration is placed at the top under the roof and the cold air drops through the rooms beneath through air passages.

The refrigerating-plant is of Messrs. Sulzer's ammonia compression type. Compound compressors, combined with after-coolers, are used, the latter raising the efficiency of the plant. The arrangement is shown in Fig. 2. The condenser A is located over the power-driven compressors in the engine room; the after-

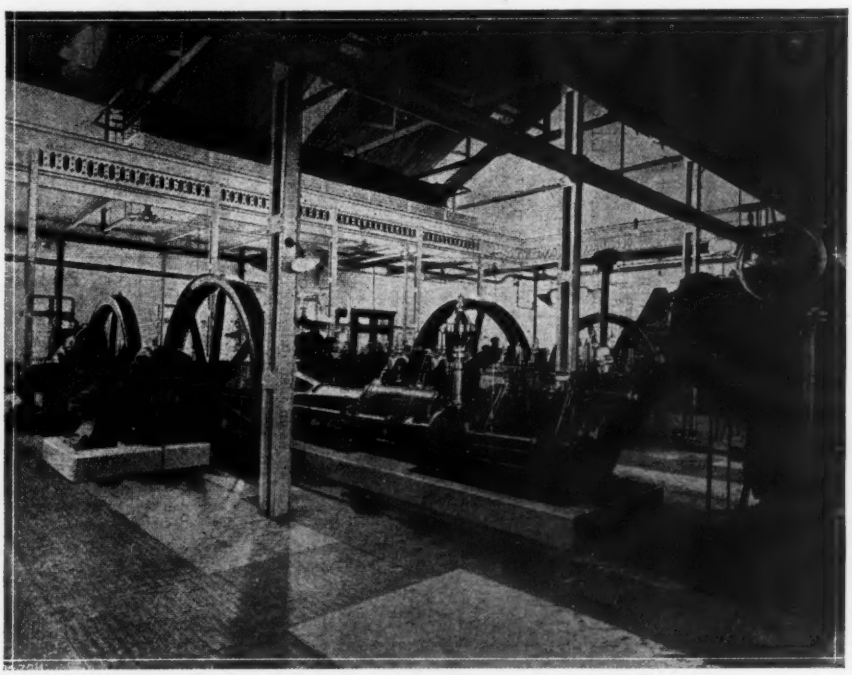


FIG. 3. INTERIOR OF CUATREROS POWER HOUSE

cooler B is placed in any suitable position, and the various expansion sets C are distributed under the roof of the building in which refrigeration takes place.

Fluid liquified in the condenser A flows, with a view to lowering its temperature still further, to the after-cooler B, through the pipe b, and thence to the expansion sets C. A small pipe marked c, opens into the connecting-pipe b and forms a serpentine inside the after-cooler B. A small proportion of the fluid of the condenser A flows through this pipe c, vaporizing inside the serpentine of the after-cooler B, thereby expanding to the pressure of the low-pressure cylinder.

The plant works as follows: The vaporised refrigerating agent is drawn by the pipe b into the low pressure left-hand cylinder, where it is partly compressed. It is then compressed to its final pressure of 8 to 14 atmospheres (117 to 205 lb. per sq. in.) in the right hand cylinder, whence it flows through the pipe a to the condenser A. Water is made to drip constantly over the tubes forming this condenser, and this, by cooling the gaseous refrigerating agent, causes it to liquefy.

Liquid ammonia then passes through the pipe b to the vaporisers or freezing sets C, flowing on its way, as aforesaid, through the after-cooler B, in which

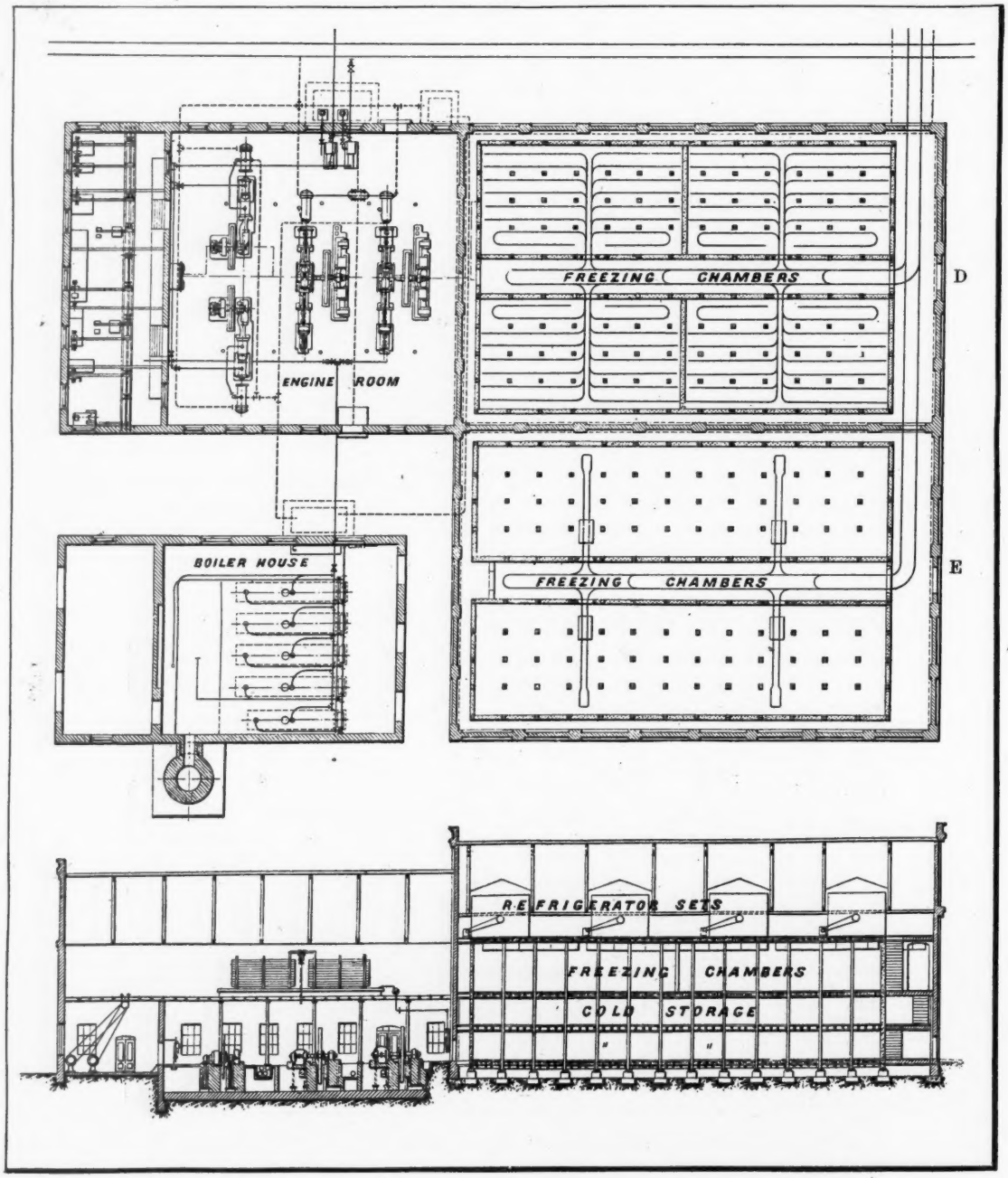


FIG. I. CUATVEROS PLANT AT BAHIA; PLAN AND ELEVATION THROUGH ENGINE ROOM

it is cooled to about 32 deg. F. A small portion of the refrigerating agent—10 per cent at the most—is branched off through the pipe c. The refrigerating agent enters the pipe c at a pressure up to 14 atmospheres (205 lb. per sq. in.); as this pipe c ends at the low-pressure cylinder, in which the pressure is considerably below that figure; this 10 per cent. of the refrigerating agent vaporises almost instantaneously in the serpentine of the after-cooler B, and leads to an effective cooling down of the main portion, 90 per cent. of the refrigerating agent circulating round the serpentine in question. Regulating valves are fitted in the pipes b and c.

Each compressor is coupled to a trip-valve engine, having cylinders 14.17 in., 23.62 in., and 35.43 in. in diameter, with a 27.56 in. stroke. The engines run at a speed of 62 to 75 r.p.m. The high-pressure and intermediate cylinders are at one end of the engine, and the low-pressure cylinder, with a surface condenser of 377 sq. ft. cooling surface, at the other end. For steam condensing, the overflow water from the ammonia condensers is used.

Two compound engines are used for generating current for light and power; these have cylinders 9.05 in. and 15.75 in. in diameter, 27.56 in. stroke. They run at a speed of 130 r.p.m. The surface condenser is located below the high-pressure cylinder. Each engine is direct coupled to a Siemens and Halske 110-volt 550-ampere dynamo.

The boiler-house contains 4 horizontal boilers, each having about 625 sq. ft. heating surface, and working at 11½ atmospheres (169 lb. per sq. in.) pressure. A fifth (smaller) boiler is also available. The plant contains, further, 2 condensing-pumps, having a capacity of 2420 gal. an hour; a Green economizer is also provided. The necessary draft for the boilers is insured by a chimney 130 ft. high.

Refrigeration takes place by indirect air cooling. As above stated, the freezing sets for cooling the air are located directly underneath the roof of the buildings D and E. The air cooled in the plant sinks through conduits into the refrigerating-rooms, surrounds the quarters of meat which are suspended in the latter, "yields up gradually its low temperature," becomes lighter, and rises back to the cooling sets above, where its temperature is again lowered, the same process being repeated. The air circulation in the building D is increased by a fan for each separate room containing a freezing set C, which draws the less cold air from the refrigerating rooms containing the

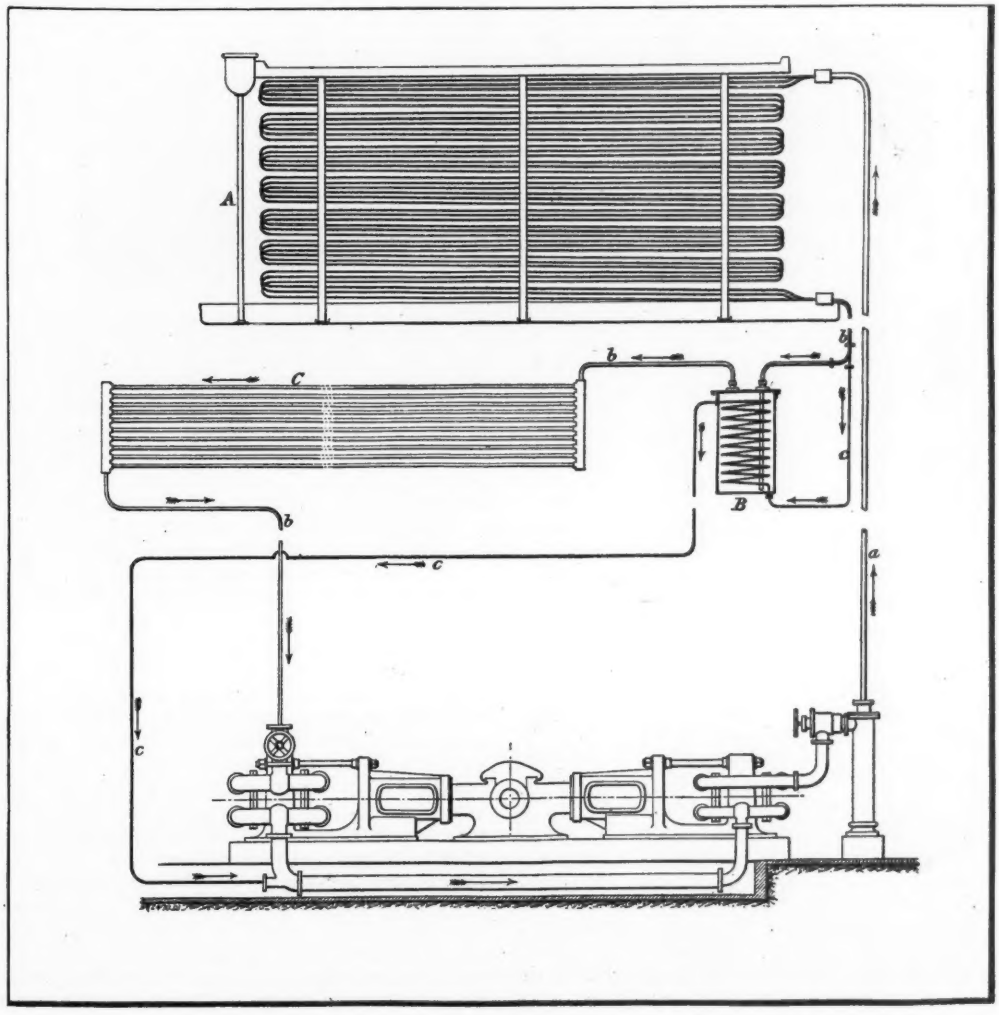


FIG. 2. ARRANGEMENT OF REFRIGERATING SYSTEM CONNECTIONS

meat. This means of obtaining an artificial circulation of the air has not been adopted in the building marked E, mainly because, owing to the lesser height of the refrigerating-rooms containing meat, 7 ft. 3 in., a natural air circulation is sufficient.

Each building, D and E, contains 8 refrigerating batteries arranged in sets of 4. The total cooling surface of each battery-room of the building D is 2850 sq. ft.; that of each battery of the building E is 2660 sq. ft. As dampness is removed from the meat during the freezing process, there occurs a continous precipitation, and the pipes of the freezing sets C have to be

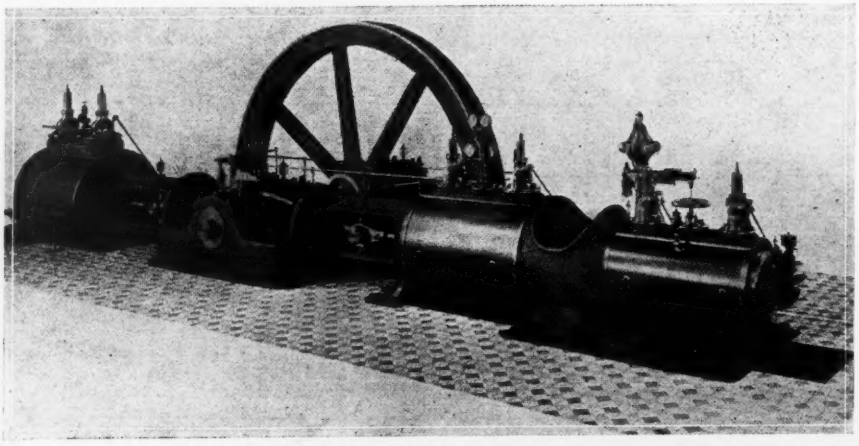


FIG. 4. TRIPLE-EXPANSION, STEAM DRIVEN COMPRESSOR

periodically freed of the frost which covers them. For this purpose the refrigerating sets are isolated from the refrigerating-rooms, and the temperature in the latter is not increased in any way during the interval for removing the frost.

Cold air circulation is regulated by valves inserted in the air-conduits. In the refrigerating-rooms the temperature varies from 95 to 5 deg. F. The working of the refrigerating-rooms depends in a great measure upon the temperature and dampness of the atmosphere for the time being.

Both the ground floor and the first floor of the building D are divided into cold-storage rooms. The temperature in the cold-storage room varies between 41 deg. and 17 deg. F. The cooling pipes of the cold-storage rooms are located in the rooms themselves and they serve to maintain the meat in its refrigerated state. As there is no dampness to deal with in these rooms, no frost precipitation occurs on the cooling-pipe coils.

All of the buildings are carefully insulated. The walls are provided over their whole height with air spaces 30 in. in width, the outside walls having windows, so as to enable an energetic ventilation of the air insulation spaces; this means has been taken owing to the fact that the ground-water level is comparatively high, and the risk of flooding had to be reckoned with. The partitions, floorings, and ceilings are also carefully insulated by means of layers of impermeable cardboard and layers of cork covered by wood panels on both sides.

The Montevideo plant was installed on a large scale in 1903. The 2 large double-acting compressors of the original plant have a capacity capable of abstracting 1,190,000 B.t.u. per hour each. A third double-acting compressor of 2,180,000 B.t.u. was put down in 1908, the total capacity being, therefore, of 4,560,000 B.t.u. an hour. A fourth, similar one is being completed.

INCREASED CAPACITY FOR ICE

TO get the best economy out of an ice plant, the capacity must be kept at a maximum, and frequently the method of operating a plant has much to do with the amount of ice produced. An illustration of this is the case of a plant mentioned by Andrew Blair, Jr., in the Cold Storage and Ice Trade Journal of a 7 by 12-in. tandem steam driven compressor, guaranteed to give 4 tons of ice in 24 hours.

At first they carried the frost down to the valves of the compressor and, running at 90 r.p.m. could make only 30 300-lb. cakes in 24 hours.

This summer they changed the operation, carrying frost on the suction side only and letting it show on the suction pipe coming from the freezing tank, but never allowing frost on the compressor. If live frost showed on the suction pipe coming from the tank, the expansion valve was closed a little, and when the frost started to melt the expansion valve would be opened.

Gage pressure was carried at 150 lb. on the high side and the back pressure regulated by the expansion valve. It was found that by operating the expansion valve when frost came or went on the pipe coming from the tank that it checked the frost before it got to the compressor, and frost carrying over to the compressor was found to decrease the capacity of the machine. By speeding up to 93 r.p.m., and observing the conditions as stated, the capacity of the machine was increased to 40 300-lb. cans in 24 hours, an increase of 33⅓ per cent.

Another change in operating was cutting out the reboiler. It had always been thought necessary to use it in order to get clear ice, but this summer the reboiler was shut off and if the freezing temperature was kept at 17 or 18 deg. F. or above, the ice was as clear as before. If the temperature got below 15 deg., the ice would be a little cloudy, as it froze too fast to allow air to escape from the water in the cans.

BRASS AND STEEL may be cleaned quickly and cheaply by rubbing with vinegar and salt, or with oxalic acid. Wash immediately and polish with Tripoli earth and sweet oil.

PRACTICAL REFRIGERATING TOPICS

Papers and Discussions Before the Practical Refrigerating Engineers' Association at the Houston, Tex., Meeting

PRESIDENT W. H. BEISLEY, in calling the convention to order, extended greetings to all, and commented with justifiable pride on the large attendance, the interesting program of papers, the number of applications for membership and the solid basis and substantial progress of the Association.

Following the president's address, H. C. Hook introduced Public Works Commissioner, J. Z. Gaston, who welcomed the members in place of the mayor, who was not able to be present. Mr. Gaston spoke of his incredulity when in 1872 it was proposed to build a plant in Atlanta, Ga., to make ice, and of the probable sensations of a Roman Emperor, who might, in a modern hotel turn a faucet and draw iced water from the wall. He pointed out the certainty of the future progress, that the mysteries of today become the common knowledge of tomorrow, and the need of coordination of the work of the man of science with the man of business, the practical man and the laborer in order that the finished product or process may be completed and made available for everyday use.

Response to the welcome was made by F. H. Ladd of Key West, Fla., who voiced the thanks of the convention for the greeting and for program of entertainment which had been arranged. He also spoke of the objects of the Association to bring refrigerating engineers together, make them more proficient in their calling and thus benefit individual members and the refrigerating industry.

The financial report of the secretary-treasurer showed the association to be in good financial condition. Ten applications for engineers had been received from managers of ice plants and only 2 men recommended for positions, they being the only ones idle when positions were vacant. Five members had been reported out of employment.

Mr. Hook on behalf of the local entertainment committee announced the program they had prepared, which was as follows: Thursday evening a theater party, Friday evening an automobile ride to all points of interest in and around Houston; the whole day of Saturday to be spent in taking the boats at Houston and going to Morgans Point for a fish and oyster roast when that point was reached, returning in the afternoon. A rising vote of thanks was extended to Mr. Hook of the entertainment committee.

At the Afternoon Session

COMMUNICATIONS of regret at not being able to attend the convention were read, also a letter from James Cullen, secretary of the Middle States Ice Producers Exchange, inviting the P. R. E. A. to become members of the Exchange, which invitation was accepted.

Letters of endorsement and congratulation were next read from the American Society of Refrigerating Engineers, and the Southwestern Ice Manufacturers' Association, and the secretary stated that the P. R. E. A. had been elected donating member of the American Ass'n of Refrigeration.

In regard to membership certificates, O. E. Morris, chairman of the committee, reported that the reason for delay was trouble in getting cuts to suit, which are to be printed on certificates, but that they would be ready within 3 mo.

PRACTICAL REFRIGERATING ENGINEERS' ASSOCIATION DELEGATES AT THE HOUSTON, TEX., CONVENTION

The rest of the day was devoted to technical papers some of which follow.

On Friday a telegram of regret was sent to Victor H. Becker of Chicago, who was prevented by illness from being at the meeting. The report of the committee on amendments to the constitution was received and adopted, changing the dues from $3 a year to $5; establishing as "provisional members" those who have applied for membership and paid dues, but have not been examined and grade assigned; providing for a board of 3 examiners holding 1st grade certificates to investigate ability and character of applicants and assign grades, one examiner to be elected each year and to hold office for 3 yr.

Twenty-three regular members were reported elected during the year, 9 associate members and 2 honorary members.

Report of the nominating committee was, for president, F. H. Ladd, of Key West, Fla.; for vice president, H. C. Hook, of Houston, Tex.; for secretary-treasurer, J. B. Embrey, of Shreveport, La.; for director, J. E. Brandt, of Durant, Miss.; for examiner, W. H. Beisley.

It was also decided to hold the annual convention at Atlanta, Ga., in 1912. Following are abstracts of some of the papers presented.

GETTING STARTED AND KEEPING ON

Practical Advice as to Starting New Plants, and Operating Successfully an Ammonia Compression System

By Carl Nessler

DURING MY EXPERIENCE I have found engineers who would start to charge a new plant without having previously determined as to whether the joints and connections were tight, and it is needless to add that in each such case considerable unnecessary expense resulted.

According to my idea, every plant should be tested out before it is placed in actual operation, and it is my intention to indicate briefly what I consider the proper procedure for doing this; namely, the plug should be removed, or the valve sometimes put in for

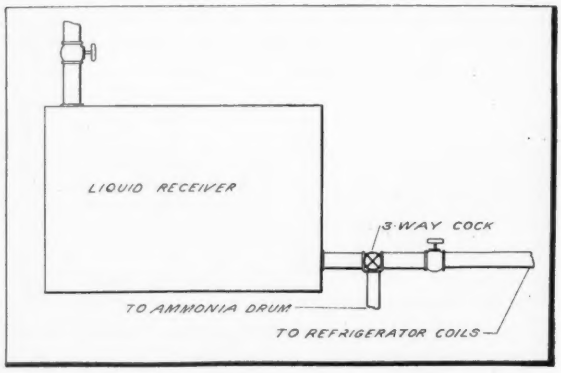


FIG. 1. USE OF THE 3-WAY COCK FOR CHARGING AMMONIA INTO THE SYSTEM

that purpose, on the suction side opened, and the machine operated until we have attained a pressure on the coils of not less than 100 lb.

Each connection should be gone over with a good strong soap solution, and if any of the joints leak, this will immediately be indicated by air bubbles.

After this has been tried out, on all of the coils, the air should be blown into the atmosphere, through a connection which had previously been made. By thus releasing the air, we shall also remove all of the fine iron particles as well as oil and other undesirable substances, which may have accumulated in the pipes during construction.

It is also a good plan to close off the condensers from the rest of the plant, and pump a pressure on them of about 350 lb., then try in the same way with soapsuds.

After everything has been found to be perfectly tight, the plug on the suction side should be replaced, and the one on the discharge side removed. Then exhaust all the air possible by pumping a vacuum on the system, and discharge the air through an opening into the atmosphere on the discharge side.

Charging the Plant

AFTER this has been done, the system is in readiness to be charged with ammonia. The opinion as to the best method to be pursued here differs with different engineers.

While some prefer to draw the gas from the flask by means of the compressor, as the ammonia evaporates in it, I am rather of the opinion that the most efficient method is to utilize the work which has been expended in liquifying the ammonia, and my observations support me in this.

This method consists in placing a 3-way cock on the side of the liquid receiver, so that the liquid receiver can be shut off and the drum connected to this 3-way cock, thereby allowing the ammonia to expand past the receiver directly into the refrigerator coils, and thence back to the machine for compression.

In view of the impossibility of extracting all the air from the system, it is inadvisable to charge with more than half of the total amount of ammonia to be used, and then relieve the air which still remains in the condensers, from time to time, during the first day or so of running. Then charge half of the second half into the plant, and continue to relieve the air at regular intervals, until all the air and foreign gas have been removed.

Purging Condensers

A VERY good way of purging the condensers, I find is to connect a pipe into the purge valve, and run it down into a bucket of water; if there is still air in the system, the water will bubble, and as soon as the ammonia appears, an unmistakable crackling sound

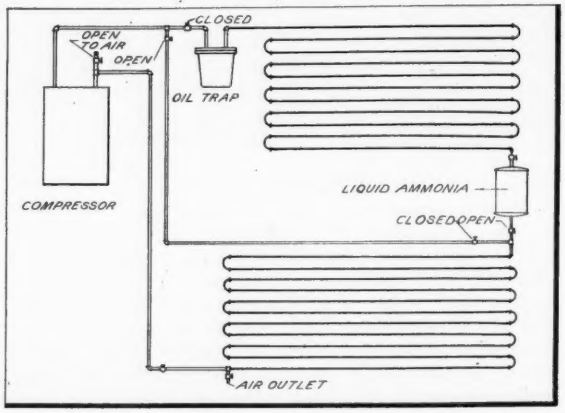


FIG. 2. ARRANGEMENT OF CONNECTIONS WHEN RELIEVING AIR AND BLOWING OUT OIL

will be heard; thereby unnecessary loss of ammonia is avoided, and also it does away with the disagreeable odor.

The compressors should be stopped sometime previous to the purging of the condensers, and the water turned on over them in full stream, so as to condense all ammonia, and to allow the foreign gas to accumulate at the top of the condensers.

Liquid Required

THE amount of ammonia required to charge a plant can be calculated approximately as follows:

About 1 lb. of ammonia is allowed for every 3 running feet of 2-in. pipe. I find, however, that the best results can be obtained by keeping the liquid receiver about ¾ full at all times.

Operation of Plant

NOW as to the operation of the plant itself, every engineer knows that too much attention cannot be given to this end.

Proper working of the compressor should be regulated chiefly by the amount of ammonia passing through it, this being done by means of the expansion valve. The pipe conveying the compressed gas to the condenser should not be too warm.

Cooling water for the condenser should be maintained at as low a temperature as possible, under natural conditions, since it is readily understood that the colder the cooling water, the lower the high pressure; and that the lower the high pressure with which we operate and the higher the back pressure the better results are obtained for a given amount of power, since the gas does not need so great a compression. If an ice making plant is operated in connection with a refrigerating plant, conditions are somewhat changed.

Causes and Prevention of Permanent Gases

UNDUE heating of the compressed gas invariably causes the formation of unwarranted amounts of permanent gases, since the ammonia under a high temperature and pressure is prone to decompose into its component elementary gases, nitrogen and hydrogen, both of which gases in their uncombined state will not condense at the average ammonia pressure and temperature.

Of course, it is also possible that permanent gases are drawn into the system at times, when a vacuum is pumped on the system, or possibly during the time of repairing.

A simple method of determining whether foreign gases are present is by listening at the expansion cock. If the ammonia passes through in a steady flow, the sound is uniform, whereas intermittent flow indicates either the presence of foreign gases or an insufficient amount of ammonia in the receiver. This is true only when the seal caused by the liquid is broken, and if that is not the case, one would have to be guided by the apparent excessive high pressure indicated by the gage.

In this connection it might ge well to mention that too often small leaks are allowed to get by unnoticed, while, on the other hand, many of us are inclined to subject ourselves unnecessarily to the disagreeable odor of ammonia.

My contention in this matter is that all the leaks, no matter how small, should be repaired at the earliest moment, and that in each case, it is advisable to have a water hose in close proximity, so that in case the odor gets too strong the water can be turned on the leak to take up the ammonia, forming a very dilute solution of ammonia hydroxide.

Small leaks in the brine tank are not infrequent occurrences, and oftentimes they are not noticed until the leak has been of long standing. For this reason I believe that the brine solution should be tested from time to time with what is known as Nessler's Reagent, which shows the presence of ammonia readily by a yellow color.

By the foregoing I merely want to indicate that through the undue heating of the ammonia and improper purging of the condensers, unnecessary waste of ammonia may be caused thereby necessitating more replenishing than would be called for under ordinary conditions.

Replenishing of Ammonia

IT must be remembered that ammonia will deteriorate somewhat and this is the only replenishing that ought to be necessary. And this, according to my idea, should not be more than 100 to 200 lb. of ammonia per annum for a 50-ton plant, or in that proportion.

Another good plan in this connection is to provide an arrangement whereby the attemperators in the various vats can be tested out individually at regular intervals, as to whether they are tight, thereby avoiding considerable inconvenience and sometimes great loss.

Proper Temperatures

TEMPERATURE of the brine, when refrigerating with this medium, should be about 5 to 10 deg. higher than the temperature corresponding to the indicated back pressure.

For a direct expansion system, the pressure on the refrigerator coils should correspond to a temperature which is about 11 to 12 deg. below that of the temperature desired in the refrigerator. It is well, however, to state in this connection that the pressure at all times will increase, if left alone, until it corresponds to the temperature of the refrigerator.

For ice making, the best temperature at which to keep the brine is about 11 to 14 deg. F., and the proper back pressure to have in order to maintain this temperature would be about 15 lb.

It is the contention of some that the most satisfactory work is done when the coils in the refrigerator are heavily frosted. This, however, is an erroneous idea; since the thicker the coating of ice on the outside of the coil, the less will be the interchange of heat between the external and internal medium, since this coating of ice acts as an insulator to a certain degree.

In addition, this heavy coating of ice adds considerable weight to the pipe, and I recall an instance where this caused quite a disaster, the weight having been so enormously increased that the wooden supports to which the coils were fastened gave way, thereby causing the entire cellar to be filled with ammonia.

Oil in the System

TOO little attention, in my opinion, is paid to the oil which is bound to get over into the system, and can be noticed in the refrigerating coils, in so far that parts of the pipes will be coated with ice, while other parts are not even frosted.

There are several reasons for this, first, that the oil is not removed at the oil trap at regular intervals; and second, that the oil is not properly separated, but is carried along by the high velocity of the gas into the condenser.

A very good policy is to pump out the entire refrigeration system, bottling all the liquid into the condenser and liquid receiver; then by the proper manipulation of bypasses, pump pressure on the refrigerating coils to an extent of 45 to 50 lb., and while the machine is running, relieve this air to the atmosphere through a connection which has previously been made from the lowest portion of the system.

In pumping an air pressure with the compressor, the compressor should first be thoroughly cleaned to prevent trouble, and run very slow.

By blowing the air through this connection for about ½ or ¾ hr., we are bound to get out any oil and scale which may have formed in the refrigerator coils. To make sure that all the oil is blown out, it best to make 2 connections, one for steam and one

for air. First blow out with steam and immediately after with air. If a boiler is used as a temporary receiver, it will give better results.

The many different types of ammonia rectifiers which are all more or less operated on the same principle, are in my opinion very good to install, since they aid considerable in settling out this oil before it gets into the system.

Testing the Compressor

IN the foregoing, I have referred principally to the operation of the plant in general, and now come to one of the parts in the compression system, that is too often neglected, and which causes considerable unwarranted loss in power.

Some engineers do not know the internal working condition of their compressors; while it is true that

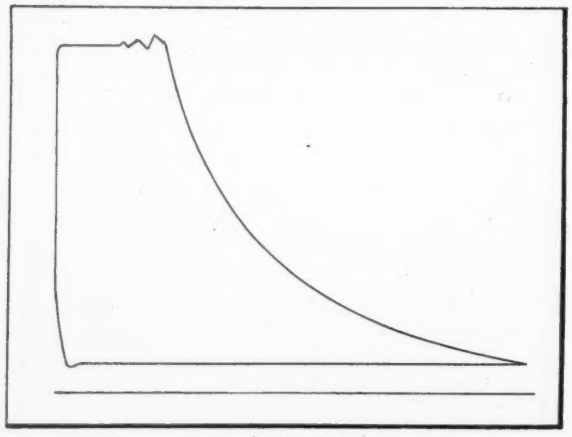


FIG. 3. PROPER COMPRESSOR DIAGRAM

they may take the machine apart regularly, clean the valves, wipe out the cylinder, etc., they do not know whether the valves seat properly, or whether the gas leaks by the piston. Not knowing this, they may have a case in which they are churning some of the gas back and forth.

Pressure Gage Method

THERE are 2 ways of determining this; but, the first one does not give the desired accuracy. This consists of putting a gage directly on the compression side and another on the suction side of the machine. By compressing the gas on one end and holding it there for some time, if the pressure does not decrease, we can assume that end to be tight; this is then tried on the other end of the compressor. Now by admitting the back pressure to one end of the machine, note whether it increases; if it does not, this is satisfactory, and should be tried on the other side.

Indicator

THE second method and the one which should be given preference is by indicator diagrams, which are taken from the compressor. These diagrams will show immediately at what part of the compression the leaks occur. But, as to whether we are receiving the proper compression, or whether we are getting the desired results from our water jacket, we would necessarily have to plot the adiabatic and isothermal curves, since it is impossible to see whether the curve we get is the proper one without having something for comparison.

Discussion of Indicator Diagram

IN a good compressor indicator card, the heel should be square, since the clearance should not be too great. We can readily see that, if a card has a round extended heel, the clearance is more than absolutely necessary, and should be reduced, since high clearance will decrease the capacity of the compressor, and demand more power than is actually necessary. If the compression line goes above the discharge line and then comes back, we can readily see that more pressure was required to open the valves than was absolutely necessary and that the spring should be relieved somewhat, so that the valve opens more easily.

If the discharge line is very ragged and peaked, this also indicates that the valve clatters, and in fact

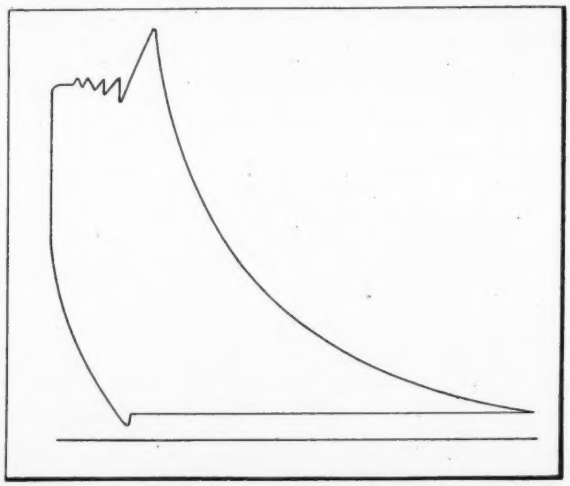


FIG. 4. DIAGRAM SHOWING HIGH CLEARANCE, COMPRESSION TOO HIGH AND CHATTERING EXHAUST VALVE

that the strain is too strong or that the valve catches occasionally.

As to the kind of indicator to use, the proper one would be, of course, the regular steel ammonia indicator; but, the regular steam indicator can be used for this purpose, if the cylinder is kept well oiled on the inside.

Conclusions

IN conclusion, it has been my contention that for the proper conduct of an ammonia refrigerating plant, the temperature of the suction and discharge side of the compressor the temperature of the cooling water running over the condensor, and the temperature of the individual cellars, should be taken every hour, or at least twice a day, and that indicator cards be taken from the machines at least once every 2 weeks.

The horsepower figured from these should be compared with the indicated horsepower of the steam side, thereby determining the efficiency from time to time. By such systematic working we can conclusively determine the condition of the plant, and keep it in proper working order at all times.

FUTURE MEETINGS of the J. C. Jurgensen Branch of the Institute of Operating Engineers will be held on the first Tuesday and the fourth Thursday of each month in the Engineering Societies Building, 29 West 39th St., N. Y. The first meeting of the month will be on Plant Management, and the second meeting will be devoted to lectures of interest to plant operators as well as talks on plant records. All engineers and their friends are cordially invited to these meetings.

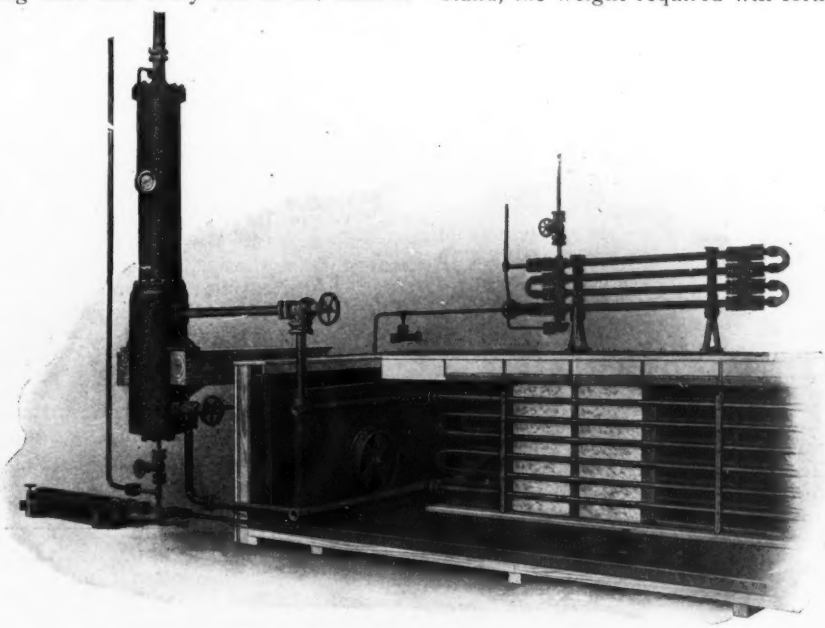
THE GRAVITY FEED SYSTEM

A Method of Automatically Supplying Each Coil of a Series with the Right Amount of Ammonia. Pointers About Application to Plate and Can Systems

By Theodore O. Vilter

THE Gravity Feed System, I call it, which is the proper name, although a great many others call it the "Flooded" System, which is not quite right. I find in my experience in traveling around the country that a great many people believe the coils in a Flooded System are full of anhydrous liquid ammonia. That is not so; as the ammonia boils, particles of gas are formed and they travel in that coil and with every foot of travel these particles of gas increase in number, so that at the end of the coil most of the pipe is filled with gas under suction pressure.

The Gravity Feed System is merely for the purpose of supplying each and every coil in the tank or



ARRANGEMENT OF APPARATUS IN GRAVITY FEED SYSTEM

in a coil loft in a chill room of a packing house, or in any series of coils that are of the same level, automatically with the necessary supply of ammonia. In forcing every square inch of surface of every foot of pipe to its fullest extent it is necessary to get the ammonia into that pipe and this apparatus does that automatically; whereas, if anybody is operating 12, 15, 30, or 40 coils with a feed cock on every coil, the man who can regulate those feed cocks has yet to be born; he is not on the face of the earth now. I have found this out in my practical experience in operating refrigerating and ice-making plants. The Gravity Feed system in connection with the accumulator is the proper apparatus to be applied and the efficiency of the plant is increased by the use of this apparatus.

In a Plate Ice Plant

TAKE, for instance, a plate ice-making plant. There are coils in such a tank that have 10 in. of ice. There are also coils in the tank that are absolutely bare of ice and as the water entering the tank on these bare coils is in all cases warmer than the ice, these pipes or coils will have to cool down the water to the ice making temperature; consequently those coils require more ammonia than other coils.

This accumulator of the Gravity Feed system accomplishes that result automatically and you are not hampered by finding, when you wake up the next morning, you have made on one coil 2 in., on another 3 in., and on another 4 in. of ice overnight. The ice forms absolutely uniform. In the plate ice plant this can be noticed, whereas in the coils of a can ice tank it cannot be noticed, and that is why in a great many cases in can ice plants the efficiency of the plant is increased by the addition of the Gravity Feed system to existing coils.

Position of Accumulator

WHEN installing this system care should be taken that the accumulator is placed above the top of the coils so as to give what you would call a head to the liquid supplying the coils. You will understand, the weight required will form a very low pressure, especially in a can ice tank where you have cans only 2 ft. deep. It is improved a bit where you have 300-lb. cans, and still more where you have 400-lb. cans, and still more when you have a plate ice plant with a tank of 9 or 12 ft. deep.

Care must be taken that the liquid pipes going from the accumulator to the headers of the tank are in a slanting position and besides those liquid pipes, if exposed in a warm room, should be carefully covered. The covering is for the purpose of avoiding boiling of the ammonia as much as possible in this liquid feed pipe to the headers. The slanting position is for the purpose of getting the gas that is liable to evaporate in the liquid supply pipe back into the accumulator and not retard the flow of the liquid, bearing in mind that you have no pressure under which the liquid goes to the coils. You must always bear in mind the gravity feed, which is no more pressure than the head of the liquid.

I just returned from a trip east where there was trouble in a Gravity Feed System. In that case there

were 3 ice tanks with 3 inlets from the same accumulator. The supply header of liquid was horizontal and to one tank it raised 9 in. and in that tank they could make but little ice. The liquid header was in a warm room and in the hot summer days, of course, a great deal of boiling of ammonia took place so that the gas retarded the liquid flow to the coils and especially in the pipe that raised the tanks where but very little ice could be made.

I think the above will be of interest to you because it comes from a practical engineer and not from a theoretical proposition.

DISTILLING SYSTEM

Action of Triple Effect Evaporators in Giving Pure Water and Amount of Water Furnished

By F. H. Ladd

AT Key West, Fla., where I am now located, about 17 yr. ago, we used a coil evaporator, using the condensed water from our compressors engines and auxiliaries for ice, and the evaporating plant for make up water for our boilers. Key West is peculiarly situated; located nearly at the extreme western end of the Florida Keys it is of coral formation, and no fresh water is found in its soil or rather coral rock.

The city of about 25,000 inhabitants depends for fresh water for drinking and domestic use on the storage of rain water of which the yearly precepitation is about 38 in. The U. S. Government has had in operation here 2 distilling plants consisting of 3 effects: the first effect under about 15 lb. live steam pressure, the third about 18 in. of vacuum. These have been fairly satisfactory, but have not been very economical in use; in fact, I do not think they have ever been run on an economy test, but mainly for quantity of output.

Their great drawback has been in cleaning. The water to be distilled is circulated through the tubes, the steam being on the outside; a scale of exceeding hardness is formed inside these tubes which is very difficult to remove, and, as this deposit takes place rapidly, it soon cuts down the capacity of the plant to a very appreciable extent. About 6 yr. ago, we designed an ice plant to meet our peculiar requirements in which was installed one of the latest improved distilling plants, with mechanical circulation of the water for distillation which, with some modifications has proved successful in use.

I gather that what we wish to know is how we can cut our compressor engines down to their lowest point in steam economy and yet produce enough pure distilled water to make can ice up to the full capacity of the plant without recourse to the live steam condenser for makeup water. There are several manufacturers on the market today with machines that they will guarantee to make from one-half to several times as much pure distilled water as the amount of steam delivered to it. I will try to explain the workings of such a plant and for example will take one that has triple effect evaporators. This plant would contain in addition to the 3 effects or evaporators a surface condenser and air pump. The air pump is connected through the surface condenser to the third effect.

Each effect is divided into 2 spaces or compartments, one of which we will call the steam and the other the vapor compartment. The steam from our compressor engines and auxiliaries enters the steam compartment of the first effect at, say, atmospherical pressure, which would be 212 deg F. It is condensed as it heats the water on the opposite side of the tubes to the vaporizing point, and is trapped away either through an oil separator, reboiled and skimmed, for ice making, or through an oil separator to the hot well of the boiler feed pump.

Vapor that is generated in the first effect passes over to the steam end of the second effect at about 212 deg. F. Here it is handled in the same manner as in our first effect with the water for distillation on the opposite side of the tubes, but with this difference. On the vapor side of this effect we will find by the gage about 14 in. of vacuum. Now as the water boils at 176 deg. F. under 14 inches of vacuum we find our steam end is about 212 deg. F. We will get nearly as much vapor from our second effect as we did from our first. The condensation of steam that we have used from our first effect in the vapor end of our second effect to produce this evaporation and which is entirely free from oil is trapped away to our surface condenser.

Steam from the vapor end of our second effect is carried over to the steam end of our third effect, and the evaporation is repeated the same as before except that the vapor end of the third effect which is connected to our surface condenser will be under say, 26 in. of vacuum, in which case the water of distillation will boil at 126 deg. F. You no doubt know or have discovered long before this that the principle that these plants work on, is the well known fact that water boils, that is, it gives up its vapor at a constantly decreasing temperature as the vacuum to which it is subjected is increased, as for example, at atmospheric pressure which is 14.7 lb. absolute, it boils at 212 deg. F., while at 26 in. of vacuum the boiling point is 126 deg. F.

The amount of distilled water that can be produced depends upon the amount and temperature of steam that is used in the first effect and the number of effects it would be economical to use, which varies from one to 8 and is a proposition that can be readily worked out to meet the requirements of each individual plant, as also whether it would be economy simply to use the steam from the auxiliaries in the effects for make up water, leading the exhaust steam from the compressor engines directly to the surface condenser, thus obtaining the benefit of the full vacuum carried on these engines or any combination that may be found most economical for each individual plant.

We all realize that the day has come in the manufacture of ice when we have got to look for, and study any means that will look to the economy of the output of our product, and the running of our machines at the lowest steam economy, using the exhaust through the distilling or evaporating plant for the additional make up water offers a field for our closest investigation, but each operating engineer will have to work out the equipment that will result in the greatest economy for his individual plant.

One automobile owner advises that if you wish to start your machine early and without difficulty during cold weather, best results will be had by taking out the spark plugs and keeping them warm. His theory is that moisture collects on the plug if not removed, and this must be removed before the engine will spark and ignite properly.

LUBRICATION OF REFRIGERATING MACHINERY

By George A. Burke

THIS subject naturally divides itself into 3 parts: The bearings, the steam cylinders and valves, and the piston rods and cylinders of the ammonia compressor.

The lubrication of the bearings of an ice machine may be considered as an ordinary slow speed engine, and presents no more problems than that of an engine of this type. A good grade of engine oil answers the purpose.

In lubricating the steam cylinders and valves of an ice machine, there are 2 factors to consider. To get efficiency in the steam end and avoid wear, we must properly lubricate the surfaces, and to produce good ice, we must avoid the presence of oil in the condensed steam, from which the ice is usually made. Neither of these factors may be overlooked, and to some extent they are dependent upon each other.

It is possible to secure perfect lubrication, and still have ice that is discolored by oil, and it is also possible to produce perfect ice at the expense of a badly lubricated engine. A cylinder oil to perform both duties, should be of the highest grade of oil that can be produced, and one adapted to these special conditions. This should be a light colored filtered oil.

By using a mineral cylinder oil, we are able to separate the oil more readily from the condensed steam, by means of filters, oil separators and reboilers, than by using an ordinary compounded oil; but in doing this, we encounter a lack of lubrication in the cylinder, due to the moisture usually contained in steam under ordinary conditions. The use of mineral cylinder oil requires a much greater amount in order to lubricate the cylinder.

If an ordinary compounded oil is used to meet the wet steam conditions, we are likely to secure a good lubrication at the expense of bad ice, unless the filtering and reboiling arrangements are more efficient than is the case in most plants.

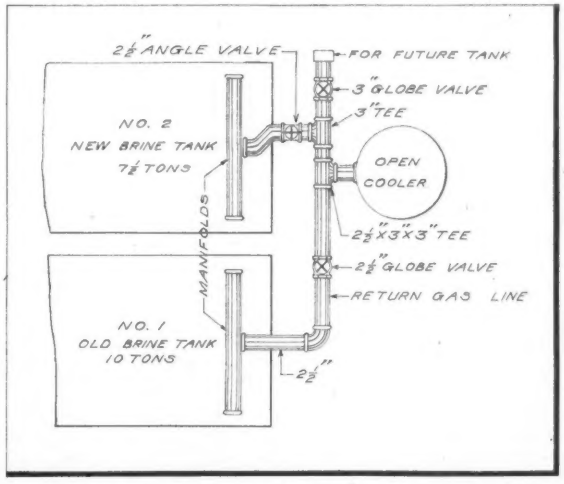
In considering the problem, therefore, it is evident that the less cylinder oil required to secure good lubrication, the less will be the quantity of oil to be removed from the condensed steam.

In the cycle of operation in a refrigerating plant, the ammonia is continually undergoing the most extreme conditions of heat and cold. The ice machine oil, being in contact with the ammonia, is necessarily subject to the same wide variation in temperature. It should be a light fluid oil of low cold test, and having sufficient wearing qualities to prevent friction on the piston rod of the compressor, which is the most important duty it has to perform. It should also be fluid enough to penetrate to the parts of the piston rod packing, and make an effective seal against the leakage of the ammonia gas. At the same time, since it is exposed to the high temperature due to the compression of the gas, it should not vaporize at the temperature existing in the compressor.

A portion of the oil is carried into the expansion pipes with the ammonia gas. Traps are provided to separate this oil, so that it may be drawn out of the system. If too heavy bodied an oil is used, if forms a non-conducting coating on the inside of the pipes, which lessens the efficiency of the system, and mixed with other impurities, such as salts of ammonia, etc., clogs the valves and causes a loss of the ammonia.

BRINE TANK CONNECTIONS; SIZE OF OPEN COOLER

HEREWITH is a sketch of 2 brine tanks connected, and I would like the opinion of readers whether the return gas from No. 1 tank interferes with the gas coming back from No. 2 tank. I could not get results from both tanks, but could shut one off and the other would work all right. The generator is a 35-ton exhaust steam apparatus, and absorber and cooler have the same capacity. The machine capacity is 17.5 tons, built to run on 3.5 lb. exhaust steam and at that pressure I would get from 125 to 135 lb. head pressure, and had on the average 12 lb. back pressure.



BRINE TANK CONNECTION WHICH GIVES TROUBLE

I would like to know also what size open cooler is required for a 40-ton ice machine, and the size of the return gas coils, and how many pipes high these should be. H. W.

RED CORE IN CAN ICE

WE have a 50-ton plant running the second year. The first year we had no trouble with red core in the ice, so when the season was over, about the first of December, we disconnected all pipes that were apt to freeze and drained them out. We noticed at the time in the pipes a small scale in the distilled water pipe, also a large amount of mud in the bottom of filters. We washed this out with hot water and steam.

The first of this season we connected the pipes and filters and were ready to start up. We ran about a week, when we discovered a small red core similar to rust. We have steam connections on our flat cooler and on our filters also; we have our water connections made so that we can reverse the current. We shut off the water on our filters and cooler and steamed them out for fully half an hour and at the same time washed them out by reversing the current, thereby cleaning all the mud and scale out of the cooler and filters. This season we were pulling 12 hr. days and would not pull nights, thereby producing 25 tons daily; therefore we would blow out our cooler and filters every day, thus keeping them clean.

We also would see that our reboiler and skimmer were skimmed at regular intervals, thereby keeping all oil and foreign matter out of the water, and we have not been troubled with red cores or dirty ice ever since we have followed this plan. J. H. Sutton.

THE VALUE OF EXHAUST STEAM IN ISOLATED POWER PLANTS

Equipment for Given Conditions

By Charles L. Hubbard

HAVING considered, in the January 1 issue, the isolated plant to some extent in connection with the central plant, so far as fuel consumption is concerned, let us now take up 1 or 2 problems relating to the best type of equipment under different conditions.

The questions which most frequently arise are the selection of the most efficient engine, and shall condensing apparatus be provided for a part, or all of the time, under the conditions involved in any particular case. In general, we may say that where the heating season is long and all of the exhaust can be utilized for a considerable portion of the time, the simple high-speed, non-condensing engine is commonly used, especially if the elevators are of the hydraulic type operated by their own pumps. This makes a comparatively light load on the engines during the summer months, when the hours of lighting are short and when open windows may take the place of ventilating fans to some extent.

As the heating season becomes shorter and steam economy is of more importance, the compound 4-valve engine may be substituted for the simple engine with good results. If the heating season is still shorter, and electric elevators, air washers and ventilating fans make up a heavy summer load, it is usually a matter of economy to add a condenser for summer use, provided cooling water can be obtained at moderate cost or there is an opportunity for using a cooling tower. Finally, when the amount of steam used for heating compared with that required for power is small, it may be more economical to install a compound condensing plant for continuous use and heat with live steam. The following examples illustrate in a simple way some of the methods employed for determining the best form of equipment to use under a given set of conditions, and may be useful as a guide in solving problems of a similar nature.

Let us take the case of an office building requiring 300 i.hp. of engines for power and lighting service, engines to be operated 10 hr. a day for 300 days in the year. Let the steam required for heating average 90,000 lb. a day for 100 days in the year. Assume an evaporation of 10 lb. of steam per pound of coal, and the cost of coal to be $3 a ton of 2000 lb. The question is, which will be the more economical, simple engines costing, say, $17 per horsepower and having a water rate of 30 lb. per i.hp. per hour, or compound engines at $22 per horsepower, with a water-rate of 24 lb?

For the simple engines the cost of fuel for power alone will be

$$30 \times 300 \quad (10 \times 300) \quad \times 3 \div (10 \times 2000) = \$4050$$

To this must be charged an amount for interest and depreciation which we will take as 14 per cent of the first cost, which amounts to $(300 \times 17) \times 0.14 = \$710.00$.

The next step is to see if the exhaust will be sufficient for heating purposes or whether live steam will to be required to make up the deficiency. Assuming 80 per cent of the steam delivered to the engines available in the exhaust for heating purposes it will amount to $300 \times 30 \times 0.8 = 7200$ lb. per hour. The average required is $90{,}000 \div 10 = 9000$ lb., from which it is evident that $9000 - 7200 = 1800$ lb. per hour must be taken directly from the boilers. If 10 lb. of steam are evaporated per lb. of coal, then $1800 \div 10 = 180$ lb. of coal will be required to furnish the live steam necessary for heating purposes. This for 1000 hr. amounts to $1000 \times 180 \times 3 \div 2000 = \$270$. This makes the total cost per year as follows:

$$4050 + 710 + 270 = \$5030.00$$

In case of the compound engines, the full cost for power is:

$$24 \times 300 \quad (10 \times 300) \quad \times 3 \div \quad (10 \times 2000) = \$3240.00.$$

Depreciation and interest:

$$300 \times 22 \times 0.14 = \$924.00.$$

Available exhaust steam, $300 \times 24 \times 0.8 = 5760$ lb. per hour, which requires $9000 - 5760 = 3240$ lb. of live steam in addition to this for heating purposes.

This amounts to $1000 \times 324 \times 3 \div 2000 = \$486.00$. making a total of $3240 + 924 + 486 = \$4650.00$, or a balance of $5030 - 4650 = \$380.00$ in favor of the compound engines.

With simple engines the weight of live steam required per hour is, $9000 + 1800 = 10{,}800$ lb. With compound engines, $7200 + 3240 = 10{,}440$ lb. or $10{,}800 - 10{,}440 = 360$ lb., making the required boiler power about $360 \div 30 = 12$, less than with the simple engines.

Noncondensing vs. Condensing

LET us next take up a case where a comparison is to be made between noncondensing and condensing engines in a factory where condensing water may be obtained by pumping from a river at an approximate cost of 1 cent per 1000 gal. for pumping. Suppose the power for lighting is to be furnished by a 400-hp. simple engine of the 4-valve type, using 28 lb. of steam per i.hp., and that the consumption of steam for heating purposes averages 8000 lb. per hour for 120 days in the year. The plant is to run 10 hr. a day for 300 days in the year. Evaporation of boilers, 10 lb. steam per pound of coal. Will it be more economical to run noncondensing or condensing, assuming an average saving in steam of 20 per cent for power purposes by the latter method? Price of coal is $4 a ton; cost of condenser, pumps and pipe line $4000. Let us take first the fuel cost with a noncondensing engine: Cost of coal for power, $400 \times 28 \quad (10 \times 300) \times 4 \div (10 \times 2000) = \$6720$.

The available exhaust for heating purposes is $400 \times 28 \times 0.8 = 8960$ lb. per hour, leaving a balance of $8960 - 8000 = 960$ lb. to be taken directly from the boilers. With an evaporation of 10 lb. of steam per pound of coal, this for the heating season will amount to $960 \times 10 \times 120 \times 4 \div (10 \times 2000) = \$230$, which, added to the yearly charge for power, makes a total fuel charge of $6720 + 230 = \$6950$.

Taking up the cost of operating a condensing plant we have the following items to consider:

Fuel cost for operating engine.

Fuel cost for heating.

Cost of pumping condensing water.

Interest and depreciation charges of cost of condensing outfit.

The item of feed-water heating does not appear in either case, as a separate item, because it has been included in the 8000 lb. steam per hour for heating requirements in each case. With the simple engine, the feed water is heated through the summer months by the exhaust, which is a waste product. With the condensing plant the exhaust from auxiliary pumps is used, which would otherwise be wasted.

Taking these up in order we have:

Fuel cost for power, $400 \times (28 \times 0.8) \times 10 \times 300 \times 4 \div (10 \times 2000) = \$5376$.

Fuel for heating, $8000 \times 10 \times 120 \times 4 \div (10 \times 2000) = \$1920$.

Cost for pumping is determined by assuming 30 lb. of cooling water per pound of steam condensed, which amounts to $400 \times (28 \times 0.8) \times 30 = 268{,}800$ lb. per hour, or $268{,}800 \div 8.3 = 32{,}400$ gal. The cost of pumping is, $32.4 \times .01 = \$0.324$ per hour, or $0.324 \times 10 \times 300 = \$972$ per year.

Interest and depreciation charges on cost of condensing apparatus at 14 per cent, $4000 \times 0.14 = \$560$, making the total fuel cost, $5376 + 1920 + 972 + 560 = \$8828$, as against $6950 for the noncondensing plant, or a balance of $8828 - 6950 = \$1878$ in favor of the latter. This, of course, will vary in different cases, but the method of making the computations remains the same and is the feature which it has been desired to bring out in the present case rather than actual values.

Running Condensing and Noncondensing

IT is interesting in this connection to see what will be the effect on the cost of operation to run the condensing plant as noncondensing through the heating season, utilizing the exhaust steam in the heating system, and using the condenser only in the summer months.

The fuel cost for power during the heating season of 120 days will be, $400 \times 28 \times (10 \times 120) \times 4 \div (10 \times 2000) = \$2688$.

The cost of live steam for heating will be the same as in the first part of the problem where no condenser was installed, and amounts to $230.

Cost of fuel for power during the summer months with condenser in use is as follows: $400 \times (28 \times 0.8) \times 10 \times 180 \times 4 \div (10 \times 2000) = \$3225$.

The cost of condensing water was found in the previous example to amount to $0.324 per hour, which in the present case is $0.324 \times 10 \times 180 = \$583.20$.

Interest and depreciation,$560, as before, making a total of $2688 + 230 + 3225 + 583 + 560 = \$7286$. It seems to be quite evident that under the conditions stated, the noncondensing arrangement will be the better, as the fuel cost is not only less in each case, but the simplicity of the noncondensing plant, and the less attention required, are also in its favor. In the examples given only the more important items have been included, if more accurate information is desired, other factors which affect the final result may easily be added.

DURING THE RECENT extremely cold weather, some of our gasoline engine operators encountered a difficulty which bothered them and caused considerable worry until the source of trouble was located. It was discovered that dry batteries are not "dry," and that the chemicals will become inactive and even freeze in cold weather, slight warming, however, restores them to their usual activity and usefulness.

TESTING CYLINDER OIL

Practical Methods Adaptable to Any Power Plant for Determining Purity and Quality

By CHARLES J. MASON

THERE are several simple tests that may be applied to oils for certain purposes, and may be conducted by the engineer in his engine room at very little expense. The test being as follows: 1. Saponification test. 2. To ascertain if there is any free sulphuric acid in mineral oil. 3. Flash tests. 4. Burning test. 5. Precipitation test. 6. Congealing test. 7. Test for acids. 8. Test for alkalies. 9. For viscosity.

To make the tests, in order named, proceed like this:

Place a small quantity of the oil in a pan of some kind, and put into the oil about 2 ounces of concentrated lye. Boil the oil for about 30 minutes and then let it cool off. After the oil is cool examine the surface, and if it is covered with a soapy substance it contains fatty matter. If the surface is clear, it is mineral oil unadulterated.

2. Take a small quantity of the oil to be tested and heat it in a pan or other convenient vessel, to about 300 deg. F. Let it stand for a few minutes, and then let it cool off. If the oil is darker in color than before boiling, it is fair to assume that there is sulpheric acid in it. Oil containing sulphuric acid should not be used for lubricating the internal parts of steam cylinders and valves.

3. Heat a small quantity of oil in a vessel to about 300 deg. F. Light a piece of stick and pass it over the surface of the oil, back and forth, until the vapor from the oil takes fire with a flash, the temperature at which flash occurs is called the flashing point.

4. Continue to heat the oil until a lighted stick passed over the surface causes it to burn, the burning point is then reached, the temperature being indicated by the thermometer.

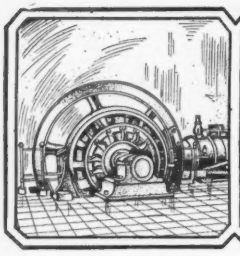
5. Place about an ounce of oil in a bottle, say of about ½ pint capacity. Then pour in about 2 ounces of gasoline. Shake up the oil and gasoline thoroughly, and allow the bottle to stand long enough for the contents to settle. If there is any sediment in the bottle, the oil has been doctored.

6. Pour out some oil in a pan, and place the pan in a quantity of ice to which salt has been added. Cover the pan with something to exclude the warm air of the room. In a short time the oil will congeal; next surround the pan of oil with boiling hot water, until the oil begins to melt, at which time the immersion of a thermometer will indicate the congealing point of that particular sample of oil.

7. Take a small quantity of oil and place in a vessel of boiling water, say about an ounce of oil to six times its volume of water. Also steep in the water a piece of red litmus paper. After the whole has soaked for a while, if the litmus paper remains red, the oil contains acid. If the paper turns to full blue, the oil is alkali. If the color of the paper changes slowly to a light blue, the oil is neutral.

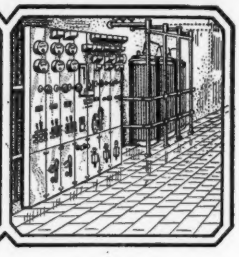
8. The foregoing test serves also for alkalies.

9. Take a sheet of glass and make an inclined plane of it by blocking up one end. Place a drop of several oils at the top edge of the glass, and note just how fast each drop runs down the plane toward the bottom. That which gets to the bottom last, is the highest in viscosity.



Electrical Machinery

For Generating, Transmitting and Using Current



MOTOR AND GENERATOR TROUBLES

In Connections and Commutator

By Norman G. Meade

SINGLE generator is often employed with a compensator connected through slip rings to points on the armature which are 90 electrical degrees from each other; the connections being made as shown in Fig. 1. This system is only applicable where the unbalancing is slight, since unbalancing will cause a reduction of potential on the loaded side and thus exaggerate the trouble.

To remedy this defect and compensate for unbalancing a booster can be used as shown at A, Fig. 1. The booster must be able to carry the maxium neutral current and must generate an electromotive force to compensate for the shifting of the neutral potential.

Elevator Motors

THE elevator type of motor shown in Fig. 2, is provided with a series and two shunt windings. The series winding is used when starting the motor and is cut out by the controller when the motor has attained full speed. It then runs with one shunt winding. The second shunt winding is thrown into circuit when stopping at the various floors. The troubles inherent to this type of motor are similar to those of a shunt and a compound-wound motor.

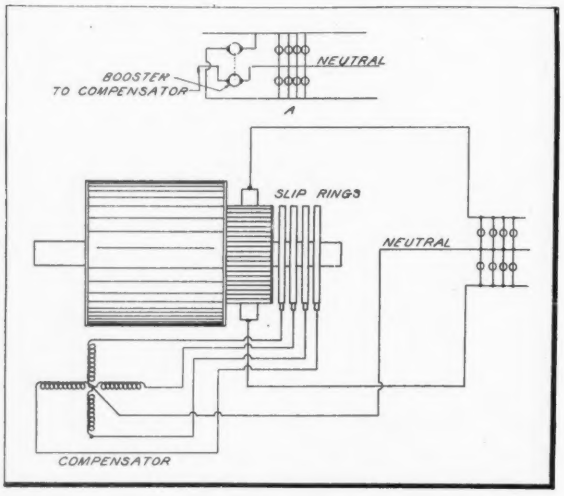


FIG. 1. CONNECTIONS OF 3-WIRE GENERATOR

Precautions To Be Observed When Starting a Motor

BEFORE attempting to start an interpole, a shunt or a compound-wound motor, test the field circuit to see that it is closed. This may be accomplished as follows: Remove the terminal at the starting box marked "Arm" and carefully insulate the end. Close the main switch and bring the starting lever up to the running position and note whether the release magnet holds the lever. This test shows whether or not the circuit is complete, as the magnet is in series with the field winding. Leaving the starting box in the above position go to the motor, and with a pair of pliers or a piece of iron, note whether the poles give a magnetic pull. In performing this operation care should be taken not to touch the field terminal thus grounding or short-circuiting the field winding. As a final or third test the main switch should be slowly

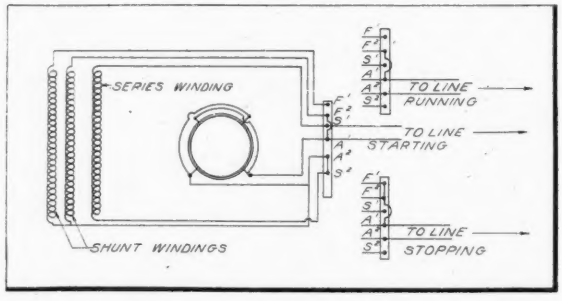


FIG. 2. DIAGRAM OF ELEVATOR MOTOR CONNECTIONS

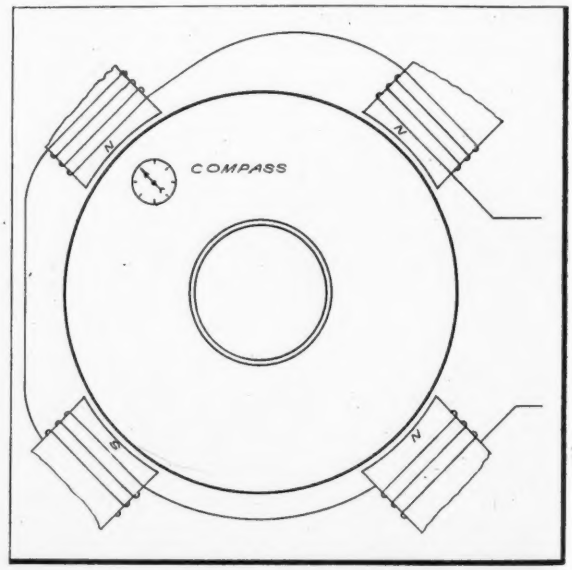


FIG. 3. CONNECTION OF ONE FIELD SPOOL REVERSED

opened and if an arc results the circuit is complete. These tests should always be made before attempting to start a motor the first time. After the tests are completed, the main switch opened and the starting lever is at the off position, the terminal should be replaced in the starting box.

In case the speed of a compound-wound motor is above normal the series-field winding is probably opposing the shunt-field winding. If sufficient starting resistance is at hand, the motor should be tried as a shunt and as a series motor. In the latter case the motor should not be brought up to speed. A few revolutions will be sufficient to show that the armature rotates in the same direction as when operating with the shunt-field winding. These tests should be made without any load on the motor and if found all right permanent connections can be made and the motor placed in operation.

When a motor is first started it should be known that all connections are tight and that the brushes are in their proper position. The oil wells should be filled

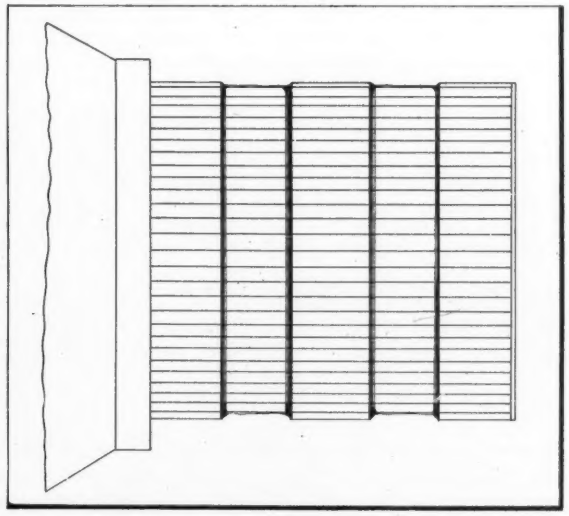


FIG. 4. GROOVES WORN IN COMMUTATOR BY UNSTAGGERED BRUSHES

and the communtator rubbed occasionally with a cloth having a few drops of oil on it until the commutator obtains a dark gloss.

Precautions should be taken never to break a field circuit suddenly, as the inductive discharge voltage is many times higher than the operating voltage and may puncture the field-winding insulation.

Care should be taken in starting a motor that the handle of the starting box is not rotated too fast. Standard starting boxes for motors up to 20-hp. are designed to start the motor in not less than 15 sec. with approximately 50 per cent over full load current. For motors above 20-hp. and up to 50-hp. 30 sec. should be allowed for starting with 50 per cent over full-load current, and for motors above 50-hp. and up to 100-hp., 45 sec. should be allowed.

Miscellaneous Troubles

WHEN a motor or generator has been taken apart for repairs it is some time found to be inoperative when placed in commission again. This trouble is generally due to improper connections or a reversed field spool. The poles in a motor or generator should be alternately north and south. If a spool is reversed there will be three poles of the same relation adjacent to each other as shown in Fig. 3. With a compass the trouble can be easily located and by reversing the connections of the coil at fault the trouble will be remedied.

Grooved and rough commutators are a constant source of trouble, causing sparking and rapid deterioriation of both the brushes and the commutator segments. Fig. 4 shows a grooved commutator caused

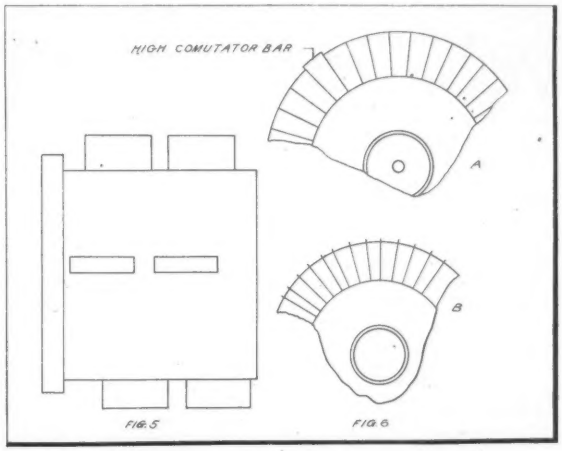


FIG. 5. BRUSHES CORRECTLY STAGGERED
FIG. 6. HIGH COMMUTATOR BAR, A; HIGH MICA INSULATION BETWEEN BARS, B

by the brushes not being properly staggered. In a direct-driven generator or a motor directly connected to a machine there is very little end play of the commutator so that to prevent grooving, the brushes must be set so that they overlap as shown in Fig. 5.

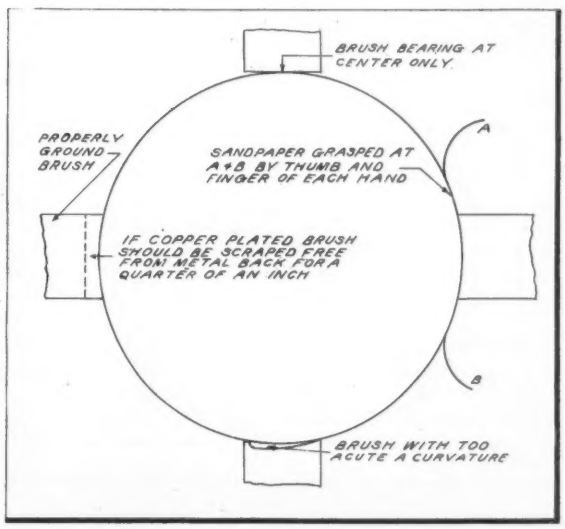

BRUSH BEARING AT CENTER ONLY
PROPERLY GROUND BRUSH
SANDPAPER GRASPED AT A+B BY THUMB AND FINGER OF EACH HAND
A
IF COPPER PLATED BRUSH SHOULD BE SCRAPED FREE FROM METAL BACK FOR A QUARTER OF AN INCH
B
BRUSH WITH TOO ACUTE A CURVATURE

FIG. 7. GETTING PROPER BRUSH CONTACT

A high commutator bar as shown in Fig. 6A is frequently the cause of sparking and can be detected by placing a pencil point against the commutator. The remedy for this trouble is to place the armature in a lathe and turn down the commutator. High mica insulation as shown in Fig. 6B is frequently caused by improper brush setting which causes abnormal heating conditions in the commutator. This trouble is reme-

died by truing up the commutator as in the former case. Improper brush setting is frequently the cause of commutator trouble and excessive sparking. Fig. 7 shows the various difficulties and their remedy.

To test for an open circuit in an armature, first clean the commutator thoroughly and connect a voltmeter with a source of current supply and two brushes diametrically opposite each other on the commutator as shown in Fig. 8. All leads should be disconnected from the brush holders and the brushes filed down so that they are narrower than the width of one segment. Rotate the armature by hand and note the deflection of the voltmeter. When the needle falls back to zero the trouble lies on one or the other of the segments

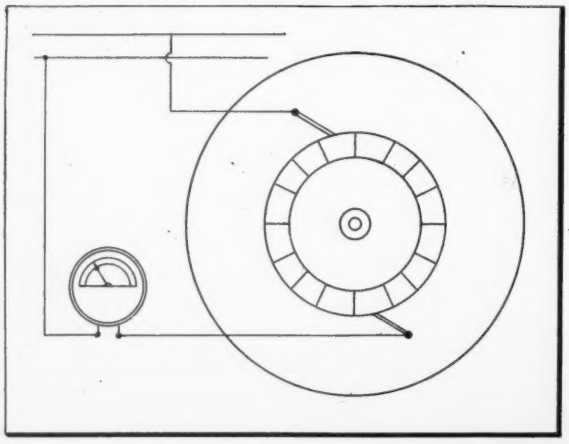


FIG. 8. TEST FOR OPEN CIRCUIT IN AN ARMATURE

on which th brushes rest. To test for open circuit in the coils or short circuit between segments remove the voltmeter and substitute an incandescent lamp as shown in Fig. 9A. Next attach copper springs to a piece of wood, having one adjustable as shown in Fig. 9B and connect them to an ordinary telephone receiver. To test for open circuit place the exploring brushes against two adjacent segments as shown and revolve

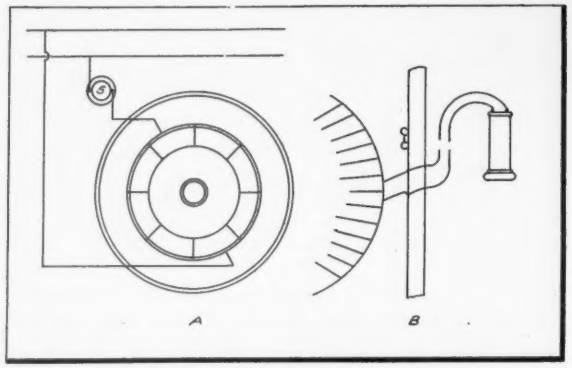


FIG. 9. TESTS FOR OPEN CIRCUITS IN THE COILS, A, OR SHORT CIRCUITS BETWEEN SEGMENTS, B

the armature as before, holding the telephone receiver to the ear. A click will be heard in the receiver as the brushes pass over the segments. If the noise suddenly increases between any two bars it indicates a high resistance or break in the coils included between the 2 segments. When 2 adjacent segments become short-circuited, a bar to bar test will indicate the location of the trouble by the absence of the click at the point of trouble.

To locate a short-circuit between 2 coils the brushes should be adjusted to include or straddle 3 commutator bars. The noise in the receiver will then be twice as loud until the coils at fault are reached when the noise will diminish. When this occurs test each coil for trouble and if individually they are all right, the trouble lies between the two. To locate a ground in the armature place one terminal of the receiver on the shaft or frame of the machine and attach the other to one of the brushes on the commutator, if there is any noise in the receiver it indicates a ground. Revolve the armature slowly and when a point is reached where the least noise is heard in the receiver there will be found the grounded point.

ROTARY CONVERTERS FOR MINING SERVICE

ROTARY converters are being used in many coal and metal mines. Direct current is necessary for the operation of mining locomotives, because alternating current motors cannot satisfy the speed and space requirements. Alternating current is used for the transmission of the energy from the steam or hydro-electric generating stations to the mines, and the rotary converter is the logical machine for efficiently converting the alternating to direct current at the point where the energy is used.

Several public service corporations in both Pennsylvania and in Colorado are making a specialty of supplying mines with alternating current energy and are developing excellent mining loads. The larger

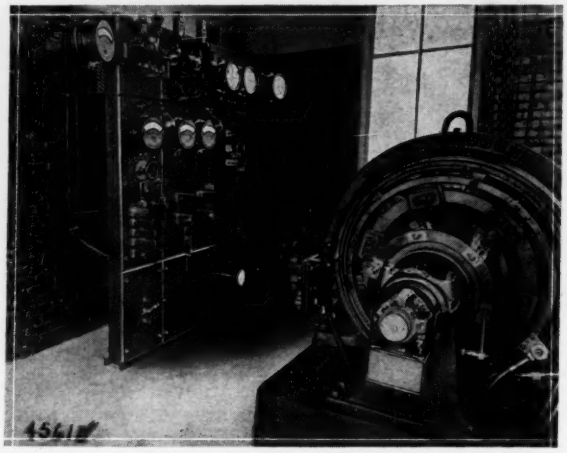


FIG. I. ROTARY CONVERTER SUBSTATION AT MINE

mining companies find it economical to establish steam or hydraulic generating stations at points where energy can be generated cheaply and to transmit it as high tension alternating current to the mine or group of mines where it is utilized. Whether alternating current is generated by a public service company or by the mining company, experience shows the rotary converter to be an efficient, reliable machine for converting the alternating to direct current. A nominal voltage of either 275 or 600 is adopted for the direct current distribution systems within the mines.

A good example of a mining plant rotary-converter installation is shown in Figure 1, which is a view of the substation at Mine No. 22 of the Consolidated Coal Company of Pennsylvania. This station receives energy as alternating current at 2300

volts, 3 phase, 60 cycles. The pressure is stepped to 158 volts for the alternating side of the Westinghouse 150 kw. rotary and is delivered therefrom as direct current at 275 volts. A standard Westinghouse black marine finished switchboard, carrying the usual switch gear and instruments, controls the incoming alternating-current line, the rotary converter and the outgoing direct-current feeders, which radiate to different parts of the property.

In large mines it is sometimes expedient to locate rotary converter substations underground near the center of the area they serve. Such an underground substation of the Consolidated Coal Company is shown in Fig. 2. The room forming the station is lined with brick which is waterproofed on the outside and the roof is arched so that it will drain and that dripping water cannot damage the apparatus. The incoming lines to this station are alternating current, 2300 volts, 3-phase, 60 cycles and the 150-kw. rotary converter delivers direct current at 275 volts. The transformers stepping down from the alternating transmission voltage of 2300 to the alternating rotary voltage of 158 are located in the substation. (See Figure 2.) A pipe frame work arranged over the high tension transformers supports the high tension bus-bars. A 2-panel black marine finished switchboard

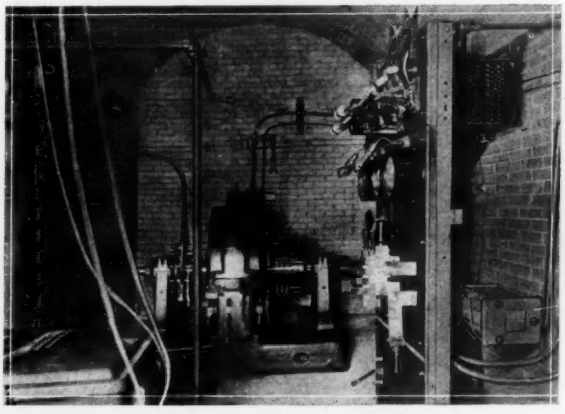


FIG. 2. UNDERGROUND SUBSTATION

carries the equipment for metering and controlling the incoming and outgoing lines, the transformers and the rotaries.

Armored lead covered cables are generally used to convey the high voltage energy to an underground substation in a mine. The cable is usually carried down a bore-hole rather than through the workings, so that the chances of injury from falling rock and from interference will be minimized.

BUYING COAL

FOR some time the government has been buying coal on its heating value and by this means has secured a better grade of fuel without increase in cost. The results of this method of buying have been assembled in a bulletin issued by the Geological Survey for the benefit of manufacturers.

Mr. Burrows, who is in charge of this work, states in regard to the specifications that they are drawn considering price and quality. Bidders are requested to quote prices on the various sizes of anthracite, a definite standard of quality being specified for each size, which must be met at the quoted price. For bituminous coal, the specifications call for a price and a standard of the coal be given. Awards for anthracite are made to the lowest responsible bidder and for bituminous, to the bidder offering the best coal at the lowest price.

For coal delivered which is of better quality than the standard set, the contractor is paid a bonus proportional to the increased value of the coal. For coal of quality poorer than the standard, deductions are made from the contract price proportional to the decreased value of the coal. The actual quality and fuel value are determined by analysis and test of representative samples taken in a specified manner by agents of the government and analyzed in the fuel testing laboratory at Washington.

At present 40 department buildings in Washington, more than 300 public buildings throughout the United States, navy yards, arsenals, and the Panama railroad are buying their fuel in this way.

A premium is paid for any decrease of ash below 2 per cent from the standard set at a rate of 1 cent per ton for each 1 per cent decrease in ash. Deductions from contract price are made when ash exceeds the standard established by 2 per cent.

The advantages of such buying are that bidders are strictly on a competitive basis in regard to quality as well as to price, and trade names are ignored so that unknown coal may be offered without detriment to the government.

Insurance is had against the delivery of poor and dirty coal and, if poor coal is delivered, it may be accepted, but at a reduction in price. For continued delivery of coal below a certain standard, cancellation of the contract is provided.

JONES AND HIS NEW PUMP

A Slight Objection to Starting Up, In Which the Pump Was Justified

JONES, the chief, ordered a new boiler feed pump, so that he would not be dependent on one alone. In due time it arrived, and Jones at once commenced to install it, with the aid of his fireman, who acted as piper. Jones fixed the pump and the steam pipe lines, and the fireman the suction and delivery pipes, the suction pipe being 3-in. cast iron flanged.

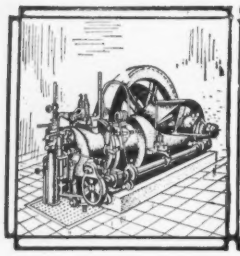
As soon as the last length of pipe was in, all was ready for the trial run. So Jones, who was already feeling a half inch taller with pride of his handiwork, opened the starting valve with care to give her a trial; but not a drop of water could be obtained.

Hurried examination of the valves revealed nothing, and after 4 hr. of trying to get water from that pump, it still refused to lift a drop.

By this time Jones had lost his half inch of pride and had exhausted his special reserve of language. He decided to go over the piping. The steam pipe was alright; so was the delivery; then they came to the suction and found that the fireman had (only) forgot to take out the wood plug, which is placed in all new valves and pipes, from the last length of suction pipe which was under water.

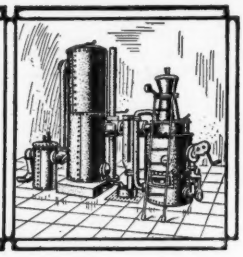
Flow of water started toward the boiler and flow of language toward the fireman. Richard Howarth.

WHOEVER IS AFRAID of submitting any question, civil or religious, to the test of free discussion, is more in love with his own opinion than with truth.—Watson.



Gas Power Apparatus

Producers, Engines and Industrial Applications



THE GASOLINE ENGINE AND COLD WEATHER

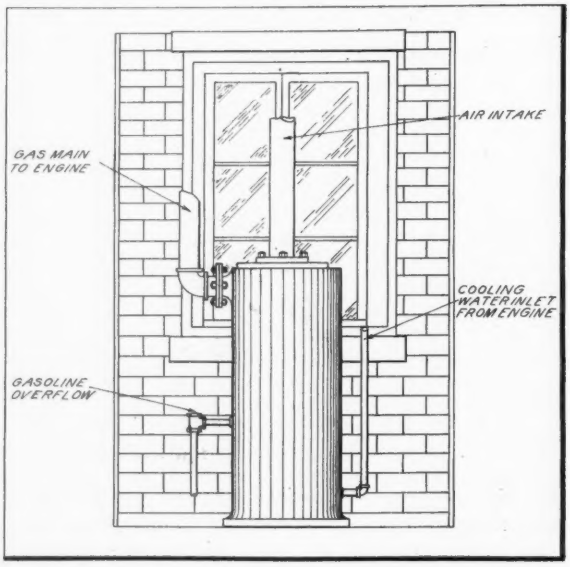
Kinks for Getting Started Under Difficulties

By C. H. Bromley

WHEN the mercury is prone to drop almost out of sight, and the operator feels compelled to try a buck and wing dance on arriving at the plant in order to warm up a bit, he finds his engine in a worse fix than himself. The usual methods of starting as used in summer are simply of no use, especially if the grade of gasoline is poor and the engine room is cold as most gasoline plants are.

With the tank filled with gasoline that has been pumped to and circulated through the carbureter "steen" times or more, and the temperature anywhere from 40 deg. F. to 10 deg. below zero, the following methods of preparing for a start have been found good; in fact I never had the engine stop after turning her over with compressed air:

Always try to have on hand a couple of 5-gal. cans of good gasoline. Get it right out of the tank wagon



LOCATION AND CONNECTIONS OF CARBURETER

or barrels when a fresh supply comes in; it's as fresh then as it ever will be. The trouble with drawing it out of the main tank is that it soon becomes weak and one is as badly off as if he went to no extra trouble at all.

Now, when ready to start, pour about 2 qt. of gasoline into the air-intake pipe of the carbureter: if the carbureter is small pour enough in to raise the level near the overflow. After doing all the other things required for starting, such as retarding the spark, splashing oil on the cranks and bearings, etc., work the gasoline supply pump until gasoline issues from the overflow. As soon as it does, stop pumping.

Having had the gas valve to the engine open quite wide and the air entirely shut off, admit compressed air for starting. The engine should get an impulse after 2 or 3 revolutions and continue to run.

If the weather is very cold, and the gasoline of a grade one could correctly call "rotten," the method as given above may be used with a few additional precautions: Take out a couple of spark plugs, if a 3 or 4-cylinder engine, and squirt a little gasoline into the cylinder; if the machine is provided with priming cups, so much the better. Having filled the carbureter, retarded the spark, etc., the engine ought to start readily and continue running.

Sometimes it will miss firing on the start and gradually come to a stop. The writer has often prevented a stop by quickly disconnecting the gasoline pump from the engine and operating it by hand very fast. The rapid dropping of the thin films of gasoline over the baffle plates of the carbureter greatly aids vaporization and the engine will get enough gas to keep her going until she warms up.

Another very good plan is as follows: Where warm water can easily be obtained, as in a plant where there is one or more small gasoline engines of 6-hp. or so, a size which is easily started, the water circulating line, outlet side, may be fitted with a tee and a line run to the water line of the big engine and connected thereto near the carbureter. The conditions of each particular case will of course determine what valves, etc., are necessary.

By starting the small engine and running the water near to the boiling point, the large carbureter can be sufficiently warmed to start with hardly more trouble than is experienced in the summer.

Sensitiveness of Gasoline Engines

AS is well known, a gasoline engine is sensitive to the mixture fed to it; this applies more especially to motors such as the automobile engine, but large engines are quickly and noticeably affected as is shown in the following case:

The engine is of the 3-cylinder type, of 50 hp., direct connected to a 30-kw. generator. A large puddle carbureter is used, and the mixture, quantity and quality, may be nicely regulated by the use of the gas and air valves, which are of the needle type, but quite large, and screw out and in as does any ordinary globe valve.

The carbureter is located near a window, as shown in the illustration; another window, not shown, located about 20 ft. from the carbureter, is the one usually opened when the engine is running so as to supply air. In this instance, the load was normal and varied hardly an ampere, and the weather was cold. Just enough mixture was being fed to the engine to hold the load, absolutely no more.

Everything was normal, voltage, load, etc., when the window near the carbureter was opened ½ in. In less than ½ min. after opening the window the voltage dropped nearly two volts; on again closing the window, without altering either gas or air valve, the voltage went up to normal in less than 2 min. The temperature of the cooling water was constant. The experiment was repeated several times and always with the same results. The same thing applies to gas engines as well as to gasoline engines.

MASTERING THE GAS ENGINE

The Two-Stroke Cycle Engine, Principles of Operation, Including Charging, Ignition, Scavenging and Governing

By C. F. Swingle

HITHERTO we have dealt exclusively with gas engines of the 4-stroke cycle type, in which 2 revolutions of the crank are required for each power stroke, the action being as follows: Stroke 1, outward, admission of charge; stroke 2, return, compression; stroke 3, outward, explosion; stroke 4, return, exhaust. As there are many small

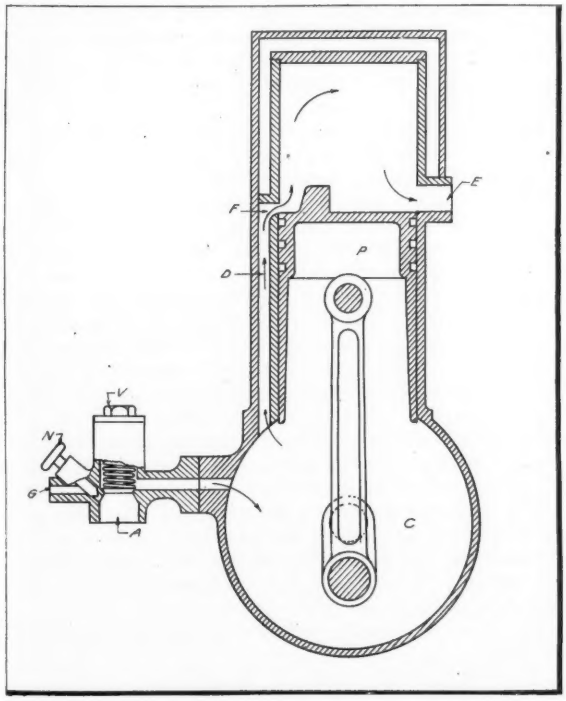


FIG. 1. TWO-PORT TWO-CYCLE GAS ENGINE

engines, and some of larger dimensions, designed upon the 2-stroke cycle principle, a space will be devoted to a description of this type.

In the 2-stroke cycle engine the charging, compression, explosion and exhaust are required also, but these events all occur during the time that the piston is completing 2 strokes, one revolution of the crank. Two-stroke cycle engines require a compression chamber, and this chamber may be either entirely separate from the cylinder except as to port connections, or the crank case may be utilized for this purpose by constructing it air-tight, and of sufficient strength to withstand the pressure of 8 or 10 lb., due to the compression of the charge previous to its admission to the cylinder. During the outward stroke of the piston the following events take place in the cylinder: 1st, explosion and expansion of the charge; 2nd, exhaust; 3d, charging, while a new charge is compressed in the compression chamber. When the piston makes the inward, or return stroke, the charge admitted to the cylinder during the outward stroke is compressed, and the compression chamber is recharged. It will thus be seen that a 2-cycle engine explodes a charge and receives an impulse at each revolution, and when the engine consists of twin cylinders, either side by side, or tandem, the charge of explosive mixture is

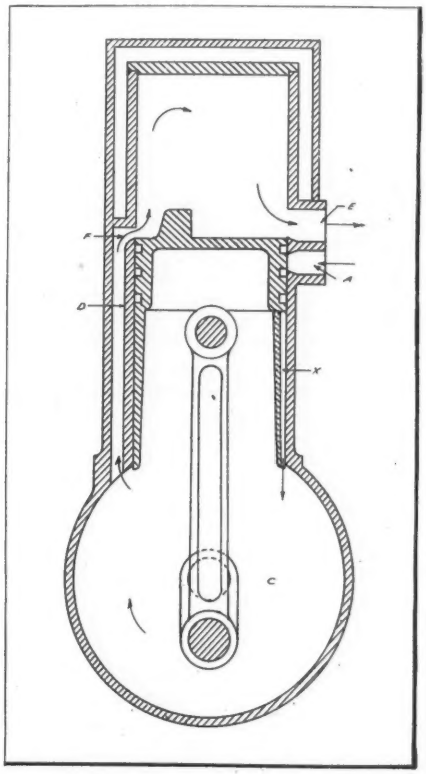


FIG. 2. TWO-CYCLE GAS ENGINE WITHOUT CHECK VALVE

being received in one cylinder, while the previous charge in the other cylinder is being compressed preparatory to explosion.

Figures 1 and 2 are vertical sections of 2 small marine type, 2-cycle gas engines, differing only in a few minor details. Referring to Figure 1, the piston, P is shown at the end of the down stroke, and during the time it has been making this stroke it has also compressed to a pressure of 8 or 10 lb. the charge of air and gas which had previously been admitted to compression chamber C, which in this instance is the crank case, and the space below the piston. The admission of this new charge is controlled by the action of the piston, which, while moving away from the crank case C, during the up stroke creates a partial vacuum in the latter.

This tends to open check valve V against the tension of its spring, thus admitting the new charge of air and gas, the air being admitted at inlet A, and the gas at inlet G, admission being regulated by the by the needle valve N.

As the piston nears the end of the down stroke it uncovers the exhaust port E, allowing the burned gases above the piston to escape. An instant later in the stroke, admission port F is uncovered by the piston, which by this time has reached the end of its down stroke, and the fresh charge, now under a compression pressure of 8 or 10 lb., rushes from chamber C, up by way of passage D, through port F, into the cylinder, being diverted away from exhaust port E by the projection, or flange shown on the top of the piston.

As the new charge rushes into the cylinder it serves to expel the products of the previous explosion before exhaust port E is again closed by the piston, which is now moving on its up stroke.

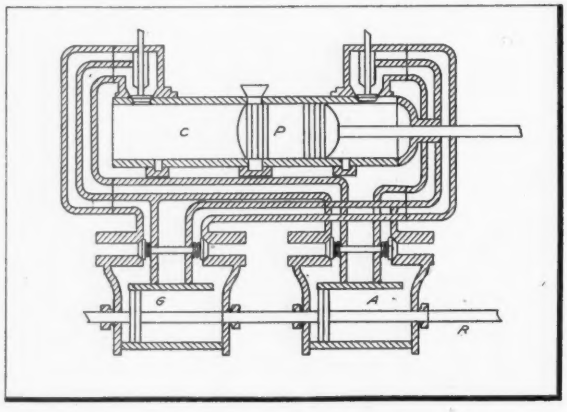


FIG. 3. TWO-CYCLE HORIZONTAL GAS ENGINE

When the piston reaches the end of its up stroke the now highly compressed charge is ignited, and the piston makes another power stroke, and also compresses a new charge of the explosive mixture just received in the compression chamber C.

This type of gas engine is known as a 2-port 2-cycle engine. Figuse 2 illustrates an engine which closely resembles that just described; the action being practically the same, with the exception that a check valve is not needed, as the piston performs the functions of inlet and exhaust valves, in addition to its own particular duty, the mixture of air and gas passing into chamber C through the port A, as shown by the arrows.

In this type of engine the rate of speed is necessarily high, the momentum of the flywheel being depended upon to carry the piston on its return stroke. The speed is regulated by throttling the governor, constructed so as to throttle the charge either in passage X, leading from port A to compression chamber C, or the passage leading from check valve V to chamber C. Engines of this type are simple and compact, the size and speed being the same, they will develop more power than the 4-stroke cycle engine, but they are not so economical in fuel, as they will consume from 10 to 20 per cent more per brake horsepower. For purposes where it is necessary to reverse the direction of rotation, reversal may be accomplished by simply changing the time of ignition.

Figure 3 is a vertical section of a 2-cycle horizontal gas engine designed for heavy service. In this engine the piston receives an impulse for each stroke, its action in this respect resembling the action of the steam engine. The air required for scavenging the cylinder when the exhaust valve opens, is forced into the cylinder by an air pump, and the fuel charge is supplied by a gas pump an instant later, just as soon as the exhaust valve is closed. Both the air pump A, and the gas pump G are double acting; one piston rod serving for both pistons. This rod R receives its motion from the main crank shaft, and the movement of the air, and the gas pump pistons is so timed that the delivery of the air for scavenging, and the fuel charge for combustion, occur at the proper time, first to one end of the cylinder C, and then to the other. This cylinder, instead of being open at the crank end, as is the case with the ordinary gas engine, is equipped with a close fitting head on each end, and the piston rod works through a gland and stuffing box containing packing which is kept cool by a water jacket. This type of 2-cycle gas engine is said to give good results as regards efficiency, etc., in installations of large power units with twin cylinders.

POWER COST*

At the Van Dorn & Dutton Co.'s Plant

By William Weber

I AM in charge of the gas engine power plant of the Van Dorn & Dutton Co., where, on July 1, 1908, we installed at our new factory a 175-hp., 3-cylinder gas engine, direct connected to a 150-kw. a. c. generator, using at that time about 150 hp.

This engine has now been running 3 years and 5 months. Counting overtime and night work (figuring 250 hr. a month), we can safely say that the engine has been running 4 yr. The only time lost on account of repairs was 45 hr., as follows:

Five hr. for a hot bearing.

Thirty-five hr. for replacing a defective piston.

Five hr. for other short stops, from 5 to 10 minutes at a time, for changing ignition, etc.

The company has been adding equipment from time to time in its machine shop until this engine was doing more than 175 hp., its rated capacity, and another engine was needed.

October 1, 1909, a 135-hp. 4-cylinder gas engine was added to the power plant, and belted to a jack shaft from which 2 line shafts are being driven at about 35 hp. Also one 30-kw. a. c. generator, belted from this jack shaft, furnishing power for our electrical department (old buildings), average 25 hp. A belted air compressor 10 by 10 in., using an average of about 20 hp., is also being driven by this engine, making a total of about 80 hp.

This second engine has been running 2 years and one month. Taking into consideration above figures for overtime and night, the engine has been running with very good results for 2.5 years without breakdown.

The average expense per month for each engine is as follows:

For the 175-hp.:	
Gas—337,500 ft., at 30c	$101.25
Oil—45 gal., at 20c	9.00
Waste—10 lb., at 9c	.90
For the 135-hp.:	
Gas—220,000 ft., at 30c	66.00

*Abstracts of papers read at the convention of the National Gas Engine Association.

Oil—40 gal., at 20c	8.00
Waste—12 lb., at 9c	1.08
Engineer—Per month	95.00
Helper—18 hr. per month, at 18.5c	3.33
	$284.56

In connection with our engines we put in a circulating water cooling system, taking care of the water for both engines, thus practically eliminating the cost of water.

The oil taken out of the crank cases is being used in some of our gear cutters, mixed with screw cutting oil, giving another saving.

Keeping Up

NEXT to the engine room is a stock room, of which I have charge. I also look after the power motors of which there are 22 in our plant; the lighting and odd wiring, and such work as is necessary in looking after the entire power plant. This takes up at least 50 per cent of my time, leaving 50 per cent for looking after the 2 engines. This shows how little attention the gas engines require if kept in proper shape.

We pride ourselves in this; we take all precautions possible, as for instance, we have a thermometer at the water outlet to keep tab on how hot the water is. Also, we apply the thermometer to the walls of the cylinder next to the crank cases, keeping tab on the heat there. We have an electric alarm attached to the water system which rings when the gas is turned on for starting the engine, and also if the water gets too low in the tank or is shut off.

We close at 11:30 a. m. Saturdays, and I have the assistance of a helper to go over the engines, taking off the crank case covers, examining the bearings, trying all bolts and nuts to see that they are tight; take out one exhaust and intake valve cage with valves of each engine, cleaning them, and grinding, if necessary.

Each Saturday the valves of one cylinder or another are taken out and given the same treatment. That means on the 3-cylinder engine that all valves get thorough attention every 3 weeks, and on the 4-cylinder engine every 4 weeks, which is amply frequent to keep them in good shape and properly seated.

All spark plugs and igniters are changed once a week, as we have extra sets. The mixing valve on each engine is taken out and cleaned once a month.

Once a week 10 gal. of oil are drawn from the crank case of each engine and replaced with fresh oil.

Every 6 months all of the oil is withdrawn from the crank cases, cases thoroughly cleaned and then replenished with fresh oil.

The foregoing figures are taken from daily records in our engine room, and at the end of the month are turned over to the cost department. Taking into consideration the foregoing expense, we add a certain floor space rental and also interest on investment, taxes, insurance, depreciation, etc. That divided by the horsepower hours shows that we are producing power at a cost of a trifle over ¾ cent per horsepower-hour at the switchboard.

AT THE S. L. PIERCE PLANT

By G. E. Pierce

IN this shoe manufacturing plant is a 120-hp. tandem engine belted to a 75-kw. d. c. generator.

The average load as indicated at the switchboard is about 65 kw., of which about 50 kw. is in motors and 15 kw. in lights, connected up on the 2-voltage three-wire system.

This plant uses natural gas at 30c per 1000 cu. ft., and has been in operation about 6 years, and during this time accurate cost of operation has been recorded.

The gas and water readings have been taken from the meters; one-half of a man's time has been charged for attention, and interest at 6 per cent and depreciation at 10 per cent on a valuation of $5,000.

A recording wattmeter is installed in this plant, so that an accurate record of the kilowatts output is obtained.

In detail the kilowatt-hour cost of current is as follows:

Cost of gas	$0.0058
Cost of water and oil	.00087
Cost of labor	.00227
Cost of fixed charges	.00417
Total	$0.01311

A SUBSTITUTE FOR ALUMINUM IN ENGINE CONSTRUCTION

IN using aluminum for the castings for engines in flying machine and automobile construction, difficulty has been encountered in getting a casting dense enough to hold the pressure incident to and immediately following the explosion in the cylinder. Also, under the constant pounding or vibration, aluminum castings crystalize and become brittle. These have resulted in cracks in the cylinder and in leakage, which leakage has been increased by the fact that the cylinders wear rapidly, thus letting gas escape around the piston.

Attempts to use a cylinder casting of aluminum around a cast-iron sleeve which should take the wear of the piston travel and hold the pressure, have been unsuccessful because of the difference of expansion between the 2 metals.

To overcome these difficulties a new alloy of aluminum called Magnalium, has been devised and is now being manufactured in Germany. It consists mostly of aluminum with a small proportion of magnesium, and not only is it lighter than aluminum castings, but lighter even than pure aluminum, having a weight only about ⅓ that of iron. In use it has been demonstrated that a magnalium cylinder with iron piston and iron piston rings gives even better wear than an iron cylinder under the same conditions, even at the high piston speed which averages 1000 ft. a minute.

The Magnalium cylinder seems to take a high mirror polish, similar in appearance to a bearing metal having a high percentage of tin. Castings of this metal seem to be much denser than those of any other aluminum alloy, and the castings are so tough that when it has become necessary to break up the castings it has been found that they must be heated to several hundred degrees and require even then a great amount of sledging.

The thermal conductivity of Magnalium is 7 to 8 times that of iron, so that heat is readily conducted through the metal which reduces the difficulty of cooling cylinders, particularly in the case of air-cooled engines. On account of the toughness and strength of the metal it is being used not only for cylinders, but also for crank cases, water pumps, intake manifolds, and various other parts of engines where lightness and high power are demanded. As already stated it is a German invention and is being handled in the United States by G. A. Crayen & Co., of New York City.

MAKING PIPE BENDS AND FITTINGS *

Methods of Handling Big Work in a Big Way

HAVING seen the method of pattern construction and alteration, the natural course of travel takes us to the foundry which is a model and one of the finest to be found in the country.

All buildings are of steel frame construction with curtain walls and a large provision of high window space which is filled with prismatic glass to give good light distribution. Roofs are steel trussed, and covered with concrete slabs shaped, arranged, and colored to resemble tiles, and having at intervals wire glass panels for the better provision of light.

In the machine shop the wire glass panels are the only roof light provided, but in the foundry monitor turrets are used to give ventilation and carry away the foundry fumes.

Following the construction of a piece of big exhaust pipe, we find first that a small brick chimney is built, resting on a heavy cast-iron base plate, and the outside of this chimney is carefully coated with loam and then with a layer of core sand. At the same time the mould is being swept up; this consists simply of a bigger brick chimney lined on the inside with loam and coated with moulding sand. Both these chimneys are then put in the core oven and baked. Then the big chimney is set in a deep pit in the floor with the little chimney placed inside it, giving a space between the two much the same as the air space between the outside of a chimney and the lining. Around the outside of the larger chimney is placed a big steel tank, and into this

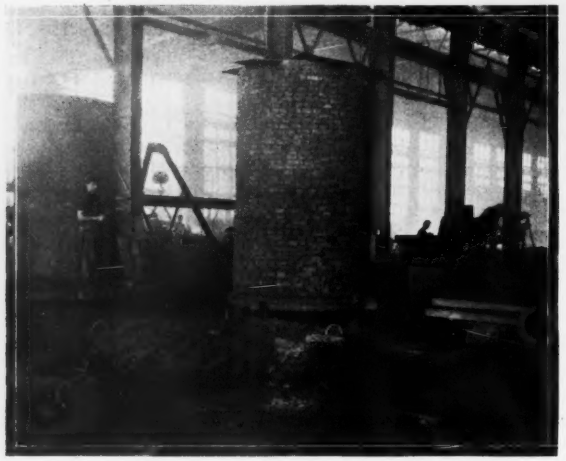


FIG. 8. CORE PATTERN AND MOULD FOR SECTION OF CAST-IRON EXHAUST PIPE

is shoveled and tamped the loam sand which serves as an outside reinforcing to the mould. Figure 8 shows in the foreground a core and mould, and in the background the mould set in the floor ready for pouring.

The molten iron has a good deal of fluid pressure when it is poured into one of these deep moulds under a considerable head as is necessary to give a solid casting, and it becomes necessary therefore to weight down the core and the mould so that they shall not float on the molten iron.

In the making of each of these big castings there are really 4 distinct operations, first, the core making, second, the mould making, third, the casting, and fourth, the cleaning up.

In the swept up moulds, the process is as has been outlined; in the floor moulds, the core is first made, either on a core frame for the large work or in a core box for the small work.

In the floor molding the core is first set half way in the floor, as shown in one of the illustrations, where a big 2 nozzled elbow is in course of construction, and the sand is rammed around the bottom half. A big flask is used for the top half, and here comes what seems like the miraculous until the process is studied. At first thought, to pick up a box full of tons of earth and expect it to stay suspended in the air, bottom side up, without the earth dropping out, seems contradictory, but by the use of iron stay rods which extend

FIG. 9. DOUBLE NOZZLE CORE BEDDED IN FLOOR

from near the surface up through the earth and by the insertion of cross beams in the flask to give the sand a grip at all points, it becomes possible to mould these great upper half flasks, for elbows and tees up to 4 and 5 ft. in diameter, without accident. The size of cores handled in this work is best shown by comparison of the ordinary objects, such as tools and pulleys which are lying near the cores in some of the photographs.

In making the moulds, the core is put in, and nicely tucked into its bed of sand all around, and the core is then carefully lifted out. The hole is cut out all around where the core has been, leaving supports at the ends so that the core may rest in its first position, and after the whole has been nicely shaped up, the core is carefully put back, leaving a space all around it which is to be filled by the molten iron.

In the Tabor compression machines, of which there are three for smaller moulds, the pattern is placed between the 2 flasks, the upper and lower, a few deft throws with a shovel to fill the box with sand, a quick squeeze by the compressed air piston underneath, rapid, accurate inspection, blowing away of the dust here and there, a little pat and a little tap at points where the corners are not quite filled and the mold is completed and set on the floor ready for the pouring.

Then there are the roll-over type, in which the mold is rammed up by hand then turned bottom up and

*Continued from page 77, Jan 15 issue.

pattern drawn by power, and there are also the jarring types in which the settling of sand about the pattern is accomplished by a bumping the bumps process, after which the flask is turned over, and the pattern withdrawn by power.

In all the smaller flasks, it is noticeable that they are tailor-made; that is, they are carefully fitted to the shape of the pattern, in this way insuring a stronger mould and a saving in the amount of sand necessary. For the standard fittings, cast-iron flasks are used, as shown in one of the illustrations, while for special fittings the flasks are of wood and the interior compartments are tailored to suit the particular shape of the casting under construction.

Where hand labor can be employed to better advantage that is used, and so at all points the work goes steadily forward with the making of moulds, the putting in of cores, and the setting away, ready for the afternoon pouring. On the mould floor are the rows upon rows of moulds, some of sand to be surrounded by wooden flasks when poured, some in the iron flasks and some in the wooden flasks with a young nursery of iron rods sticking out of the top where the reinforcing bars project.

It all sounds simple enough, but when you consider that this foundry is 320 ft. long and 176 ft. wide, it is evident that the most careful following of a well planned system must be in order, if the work of the day is to come through successfully.

Over this north bay, where the flask repair and the smaller moulds are made, is a 10 ton Morgan crane

FIG. 10. FLASKS FITTED TO THE SHAPE OF THE MOULDS

which serves also the cleaning floor where the castings are laundered. This laundering is done by means of hand work, tumbling barrels and the sand blast, and how badly a big casting needs a good scrubbing is indicated in one of the views which shows a big elbow as it came from the mould. The effectiveness of the laundering and bath is indicated by the appearance of the big double nozzle casting as it lay after cleaning and transporting to the machine shop.

And now to get a view of the kitchen and kettle where the meal is prepared which is to feed all these hungry waiting moulds. Two cupolas are installed, the big one being used for most of the work. Into this caldron where the flames are roaring, are dumped the ingredients for the meal. These consist of little iron pigs, roasted coke, a salad of scrap iron, a relish of limestone, fancy cast-iron cakes, and a seasoning of other material. The proportions are carefully worked out by the chemist who in the laboratory below, to give just the right toughness and strength to the castings, and the whole meal is carefully pre-digested by the cupola before being served to the moulds.

It is no easy matter to digest such a meal, and takes much breath, the air being furnished by 2 blowers made by the Piqua Blower Co., of Piqua, Ohio, one of them with a capacity of 101 cu. ft., driven by a 100-hp. Allis-Chalmers 3-phase motor, taking current at 440 volts, and the other a capacity of 55, driven by a 40-hp. motor of the same make.

Above, under the roof trusses, is located the charging floor which is served from the storage yard outside by a hydraulic elevator and beyond this is the brass

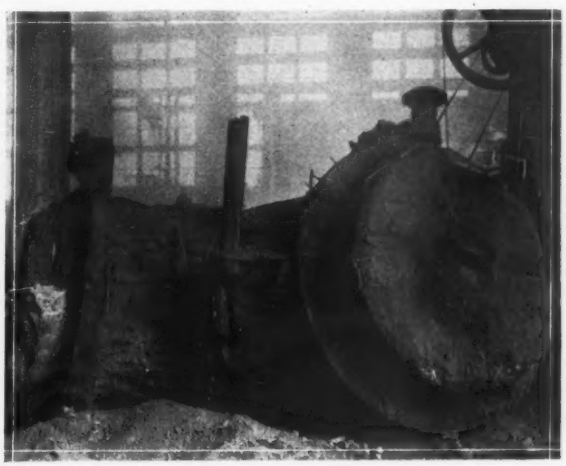


FIG. 11. JUST FROM THE SHELL. IT HASN'T BEEN SCRATCHED YET

foundry where the brass castings for the small valves, the brass parts of the large valves, and the Monel metal castings are made.

As we descend the stairs from the visit to the brass foundry, we note at the right the 3 core ovens which are heated by natural gas, with an arrangement for coke firing if necessary, and are served by the 5-ton crane which runs over the core bay; also the trucks from the oven can be run out far enough to reach under the cranes in the main bay. In the manufacture of the Best products the core oven is an important feature, for the castings of the big fittings are mostly core, and that the core shall be exactly right and of proper temper is of the greatest importance. For some of the smaller castings a green sand core is used, but for the complicated shapes and for all of the larger work the core must be carefully baked to the right degree of hardness.

The pouring of a casting is a not unusual thing, but it is always fascinating. The flow of the liquid metal, the glow from the buckets as they are swung here and there by the great cranes, the skillful movement back and forth—to right and left, and the tilting until the stream flows through into the gate of the mould, the steaming and blazing of the gases from the mould, the gradual rise of the metal in the air vents, the rush of activity, form a weird picture which is always new even though ever so old.

And when it is all finished, there are 50 tons or more of completed fittings, piping and valve bodies awaiting the cooling of the night and ready to come forth in the morning.

And now having followed the casting to the ma-

chine shop, we must visit with it through its various manipulations in drill, shaper, lathe or boring mill as occasion may require.

Different fittings go through different processes; for the flanges there is the automatic reaming and tapping machine, which at a single operation bores the flange to size and taps it ready for the driller, and then the facing lathe which brings the face true with the bore. Then comes the drilling machine, where a gang of drills, all moving busily in unision like the violin bows in an orchestra, form all the needed holes at one setting and one operation.

FIG. 12. AFTER THE BATH, AND RUBDOWN

For the valves there are the special boring jigs on lathes to bring the seats at just the right angle so that the gate will fit firmly and snugly to its seat; then follow the facings and flange borings and the preparation for the bonnet fitting.

For the larger fittings there is the facing off in planer or in boring mill so that the ends shall be true

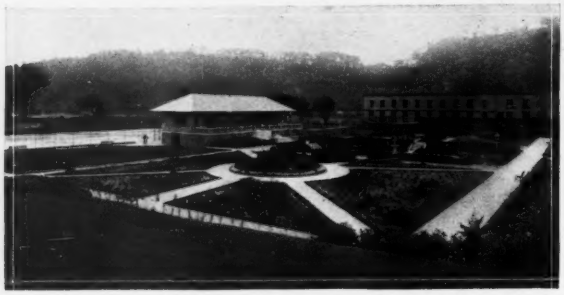


FIG. 14. FOR REST AFTER TOIL IS SWEET

and make a tight joint; and so on through the hundreds of operations for regular or special work.

All over the shop runs a system of industrial railway with turn tables, and supplementing these the cranes travel back and forth swinging here a bunch of fittings, and there a valve, and yonder a huge casting from the floor into the clear above, hurrying with it to the waiting workman at his tool, and depositing it exactly at the right point and in the desired position.

Each large tool is driven by an individual motor, while the smaller tools are driven in gangs from a countershaft, which in turn is motor driven. The feed control in all cases is by mechanical means and the motors are 3-phase induction motors and run at constant speed.

Particularly interesting are the jib cranes made from pipe and supplied with a triplex chain block made by the Yale & Towne Mfg. Co., one of these cranes being supplied to serve each of the larger tools, and one for two or more of the smaller tools. A girder crane also runs over the assembling and small lathe department in the north end of the east bay.

Far overhead, above the cranes, are placed a row of flaming arcs which with their intense light give general illumination for the main bay. Nernst lamps are supplied as already mentioned in the pattern shop, while at each individual tool is an incandescent on a flexible cord and a support of pipe or iron rod which can be moved to bring the light to any position desired, or the lamp can be easily taken off and held by hand for closer inspection. It makes a system at once simple and effective.

And now with the finished valve we go to the testing floor, where a Goulds triplex pump can furnish pressures up to 100 lb. per sq. in. if required, although 350 lb. is all that is ordinarily needed. Valve testing is accomplished by inspection to make sure that the valve is seating true and that there is no binding; the valve, which is a double disk form is then closed and

FIG. 13. SOME BEST VALVES ON THE TESTING FLOOR

pressure is applied through the bottom of the valve casting and between disks to make sure that it holds tight.

And so we are back to the carload of products ready to go on its journey in all directions from this home of the Bests, to give Best service and Best satisfaction to their users. Our visit has shown us that the plant is big not only in the ground that it covers, but also in the ideas on which it was built and in having the best equipment possible for every operation.

There is one more provision to which we need give attention, and that, while outside the plant, is nevertheless of it. This is the rest house and recreation grounds on the north side of A Street, as already mentioned and of which a view is shown herewith. Here is provided a restful retreat for spare hours or moments and with tennis courts, provision for the storage of canoes, rooms for reading or for card playing, a delightfully laid out landscape garden and pool, and seats for those who wish no enjoyment but simply to sit and rest after the day's labor.

DADDY MACDOUGAL EXPLAINS

Some Few Reasons Why Leaks and Losses Occur in the Power Plant, and Advice as to Men and Methods

MY DEAR SON:

We received your very welcome letter a few days ago and were glad indeed to hear from you again. We had about come to the conclusion that something had happened to you that you did not write, but when we read that you were chasing a few of the elusive "almighty dollars" around the coal pile and finally getting them headed straight for the treasurer's department, we agreed that you were engaged in a most worthy cause and one that requires most all one's attention to do the job right. Now, while we are speaking about the almighty dollar, let me say, Son, that there are more dollars going to waste around the average power house than most people have any idea of, even the chief and the boss.

There are several reasons why these wasteful practices are allowed to continue. Nine out of ten, the chief is not given the support of the management in letter or spirit, in his endeavors to cut the operating expenses down to the lowest possible cent. Most managers think that the power house is like a street car; if it runs it is all right; if not it isn't; and as long as it is all right it will run, and as long as it runs it must be all right. What does the average factory manager know about an engine and boiler anyway? Usually about as much as a sheep knows about a monkeywrench; but he usually thinks he knows more.

I ran across an instance like that once. A young fellow, who was pretty full of ginger took charge of a plant at the request of the owners to see whether he could stop the leaks and cut down the operating expenses. It was quite a large plant for a western city, and had been in operation but a year or so, and the first thing that attracted his attention was that there was not a foot of pipe covering in the whole plant.

He measured up the pipe, some several thousand feet of it, ranging from 16-in. down to 1-in. and smaller. Then he sent in a requisition for the necessary covering, a bill that amounted to some $2000. He might just as well have dropped a keg of blasting powder into the office with the fuse burned down to the bunghole, for the officials went up in the air and called the new engineer every name but the right one and enquired as to his certificate of sanity and also as to "what he took them for," etc.

He suavely replied that he took them "for better or for worse" and that he didn't like to see his new employers get the worst of it. Well, the upshot of the whole matter was that the management was from Columbia, "Muzzoory" and that an ocular demonstration would be highly appreciated, so the engineer gathered up his voluminous requisition and withdrew to his department of steam and power.

For several days he figured out area of pipes, variations of temperature, juggled with B. t. u., efficiency of boilers, coal, magnesia, asbestos, cost of labor putting it on, and finally got the proposition cornered in the coal bin where it couldn't get out and then he reduced the cost of coal to dollars and cents, not forgetting the amount that it cost to haul away the extra ashes of the extra coal that was burned to make steam that was condensed by the exposed piping, without doing any work.

When he got the proposition corralled, it said that it had cost the firm an average of $5.61, every 24 hours the year round, because they wouldn't let the first engineer stop up some of the little leaks, and he got discouraged and quit.

The firm wanted to know where he got his figures to work out this intricate problem and who was his outhority on condensation. He referred them to Kent. Well, the management didn't know Kent from last year's coroner, so they bundled the whole problem up and sent it to a consulting engineer in Chicago for an opinion.

No doubt they wore out a slide rule "calculating" the answer. Anyway in the course of a couple of weeks (mind you, the loss was $5.61 a day in the meantime), there came back a bulky package by express (collect 50c), and after the management had pored over a typewritten document almost as long as the Congressional Record, they discovered 2 things. One was that they had concluded that the daily loss was $5.66 instead of $5.61. Another was that a bill for $50, "For consultation regarding report on the loss by condensation of steam in uncovered piping over and above what it would be were said pipes covered with 85% magnesia covering."

Result: It cost the firm some $4000 to buy some $2000 worth of pipe covering.

So it is 10 times out of every 10, when a manager who thinks that he knows how to run a power house (but doesn't), tries to dictate on the operating and running expenses. The engineer is the one who knows how to get the best results, or should be, and if he doesn't know what oil, coal and other supplies are the best for the particular case at hand, how, do you think, can a man tell who couldn't tell cylinder oil from benzine or ladle coal on a No. 5 scoop into a fire door if it was as wide and high as Dearborn St.?

Men are in an office because they have a real or imaginary aptitude for the business. They learn how to do business in a business-like manner with business men. Sometimes they are there because they are sons of those interested in the business, or else have a pull, and must be "provided for." But at any rate, no matter how they get there, they seldom or never learn anything about an engine or boiler in the way, that qualifies them to determine which is the best brand of cylinder oil for its needs.

And then there is coal. To the average man, coal is coal, and it makes no difference whether it is Pocahontas lump or Illinois slack, it is all the same, and being the same, why should one pay $4.75 for smokeless when one can get Illinois coal that weighs the same number of pounds to the ton, for $1.95 delivered.

That is where most of the "little leaks" are around the powerhouse; they take many of the problems away from the only man around the plant who knows (the engineer), and give them to some fellow to look after who thinks that he is making a hit with the management by buying all supplies from the lowest bidder whether the goods suits the conditions or not. And that is likely why your firm, Donald, is trying to make you burn stoker coal under hand-fired boilers.

Then, to go back to the subject of our text, there is also another reason why there are leaks in the power house. It hurts the "old man" like Sam Hill to see his engineer sitting down and reading Practical Engineer once in a while. They keep him puttering around

doing a lot of small but never-the-less important jobs which, though he should have the direct supervision of them, should be done by a less expensive man, leaving the chief to give his attention to the plant as a whole and direct the work of the assistants, firemen and extra men in such a manner that there will be good "team work," which will cut these little money eaters down to a fine point, if not eliminate them entirely.

That is why your chief didn't know anything about how much coal you were burning, and I suppose that if you (or somebody else) hadn't discovered the leak, that they would have been shoveling half a dozen brand new $1 bills in with the coal every day indefinitely, to promote combustion.

Well, my son, that is what they hired you for, so while they are doing you a favor by giving you employment at the bottom of that 1000 mile ladder, don't forget that you are doing them a big favor by discovering that they were getting "flimflammed" out of 3 or 4 tons of coal on every carload, to say nothing of using 4 boilers to do the work when 3 could handle it nicely, not to mention better combustion, less repairs, and having an extra boiler on hand that can be washed out week days instead of Sundays for less money.

And then, there is that fireman. Do you know that there is a big difference in firemen? Some are called such by courtesy only and wouldn't become firemen if they stuck to it till the crack of doom. All they can do is to open the furnace doors and "load 'er up" and then go and smoke for half an hour or so till the steam begins to drop.

The real fireman studies the situation before him, and you can usually tell the real fireman by the way he goes at the job. So when you wrote that your fireman threw down the shovel and said all that bunk about "the more you do for some people, the more they want you to do," I put it down right away that there was a bully good roustabout lost to the world when he took to firing.

Now, Son, while you are doing all that coal weighing business, etc., don't make any mistakes. You know that, if the old man finds a mistake in your figures, he loses a certain amount of confidence in you, and, if you make more, why, there comes a time when he comes to the conclusion that you are all a mistake and he will proceed to bid ye farewell.

It is not the amount of work that you do in a certain length of time that counts particularly; it is the amount that you do well that makes the boss feel happy. Away back when the world was young, one of those old prophets said, "the race is not to the swift nor the battle to the strong," so you see that 2 or 3 thousand years ago, they discovered that it was the steady plugging that brought home the bacon.

So Donald, my boy, whatever you do, do it right (and you wont have to do it the second time), and you will win out in the end. Let the other fellows do all the shouting. You save your breath for the home stretch, and I'll wager that, if you have to pass them at all, you will leave them tied to the fence at the first quarter. So spit on your hands and saw wood. Make a big pile, lots of dust, and no noise.

Mother sends her love and says tell you to be a good boy. Affectionately your father,

Sandy MacDougal.

THAT DIRECTIONS for making a prony brake, with rules for testing gasoline engines, makes a good sales agent for a reliable company, is the statement of one manufacturer.

ARTESIAN WELL SUPPLY

Possible Extent of This Source

BY JOHN A. DREW

MODERN science has obviated the need of streams or lakes as a water supply for domestic and manufacturing purposes by the introduction of artesian wells, so that they have become a source of inexhaustible supply. In our own country their development and supply are phenominal. In the south and southwest arid deserts of thousands of square miles have been converted into productive lands. France has achieved the same results through the same mediums in Southern Algiers in the great desert of Sahara.

The Borough of Brooklyn has an artesian well and underground infiltrating system that yields nearly 140,000,000 gal. of water in 24 hr. This amount of water is pumped and delivered every day from this system for the Boroughs of Brooklyn and Queens. If this supply is not sufficient for the demands of the boroughs they can purchase a further supply when necessary from a number of private companies which, with the municipal stations of the Boroughs of Brooklyn and Queens combined, pump approximately 200,000,000 gal. of water in 24 hr. from this artesian well system.

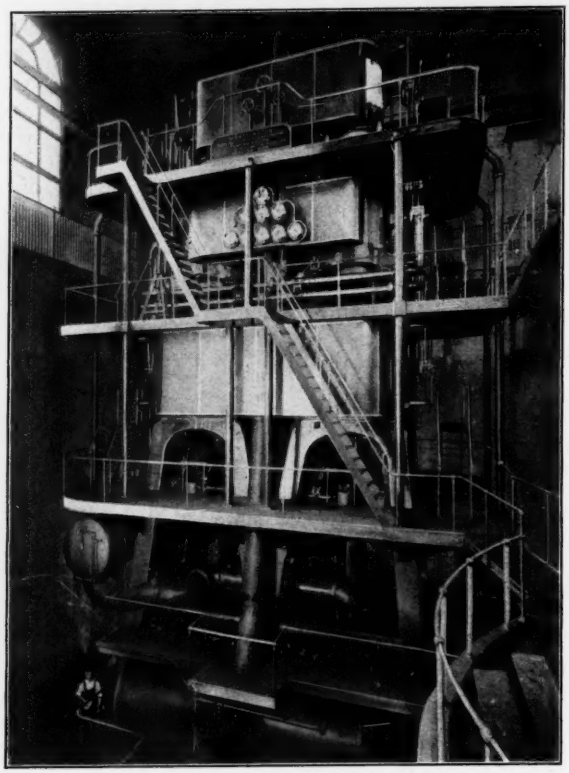


FIG. 1. WORTHINGTON TRIPLE EXPANSION PUMPING ENGINE

Eighty per cent of this yield is being handled by Worthington high-duty and triple-expansion vertical and horizontal pumping engines and Snow crank and flywheel high-duty engines of the types illustrated in Figs. 1, 2 and 3. These are high-class economical pumping engines. The Worthington triple expansion

engine shown in Fig. 1, exhibits simplicity of design and construction. The accessibility of this engine combined with beauty in design without sacrificing strength and utility in the machine, forms one of the highest excellencies in mechanic arts. Figure 2 shows the direct-acting, high-duty pumping engine of the horizontal type. This is a Worthington engine of the ordinary form of construction, but fitted with an attachment for securing the economic efficiency of a cutoff engine without resorting to the medium of crank and flywheel. This improvement marked an advance in the economy of the direct-acting pumping engine, placing it on the plane of pumping engines having obtained the highest economic results. Figure 3 illustrates the type and design of Snow crank and fly-

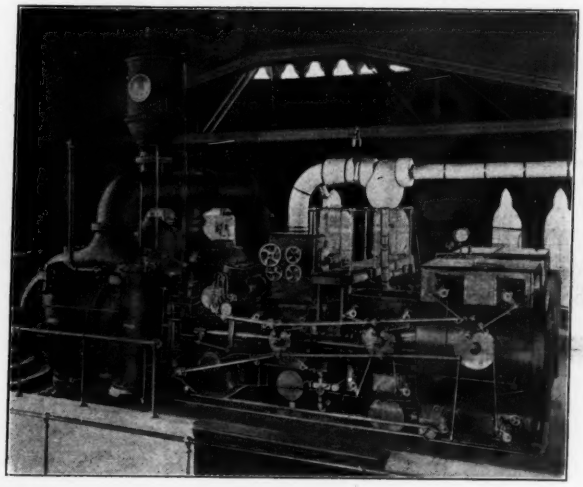


FIG. 2. WORTHINGTON DIRECT-ACTING, HIGH-DUTY PUMPING ENGINE

wheel cross-compound, high-duty pumping engine equipped with Corliss steam valve gear.

As to this Long Island source of supply, it has been problematic as to the source of this supply, but now it is quite generally believed from the geological and physical formation of the water bearing strata on both sides of Long Island Sound that a large portion of this long Island supply is coming from Connecticut

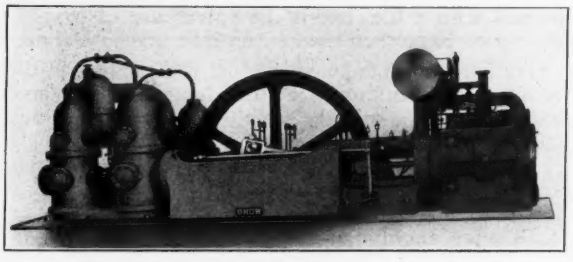


FIG. 3. SNOW CRANK AND FLYWHEEL, CROSS-COMPOUND HIGH-DUTY PUMP

and New York Shore, where there is a very deep, rich water bearing stratum probably extending from the foot hills of the Green Mountains and the Berkshire ranges in the north to New London, Conn., on the east and Hudson River on the west and to Long Island on the south. This water-bearing stratum presumably takes a wave-like course from its source in the north in its course to the ocean, dipping lower and lower until it reaches Long Island Sound, when it dips under the bed of the Sound, passing out to the Atlantic Ocean under Long Island at various depths below its surface. The breadth and depth of this water bearing stratum is believed to have been determined and the cause that produces it is not local, but regional. That there is a deep flow across the Island escaping to the ocean would seem to be shown by the presence of fresh water at the ocean front on Long Island as found by test wells.

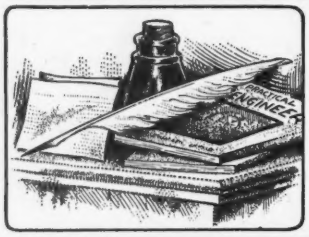
ROPE VS. BELT DRIVES

SPEAKING at first hand from extended experience, John H. Damon, of the Plymouth Cordage Co., gives in a recent article an interesting comparison of costs between some rope and some belt drives. He asserts, "First, that rope drives are many times installed where nothing else is feasible; second, that the care of rope is not generally in hands so experienced in its needs as is the belt, which thirdly, results in overlooking the care required to keep belts in proper order, but makes very noticeable the attention demanded by the rope. In other words, the average millman is blind to the fact that his belt stretches during its life nearly as much as the rope; that it has to be respliced; that it fails under load, and so on; all of which facts come very prominently before his eyes in the case of a rope when it calls for some of his care.

"Accepting the figures of 5 per cent of first cost in maintenance of an ideal belt drive, we will use 8 per cent of first cost in maintenance of a parallel rope drive. That is, one run under fair conditions and installed with low cost of maintenance as an important objective.

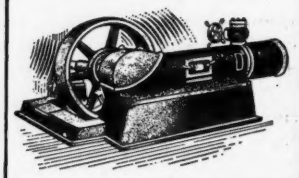
"The first cost of the leather-belt drive as a whole would be, for, say, a 500-hp. drive, with approximately 50-ft. centers, about $1270, for the rope drive about $850. Now the per cent cost of maintenance should not be from these figures, but from the cost of the belt or rope. Let 6 per cent be charged to each drive for fixed charges of pulleys and sheaves; this would equal, at first cost of belt pulleys of $375, $22 for the belt, and at a first cost of rope sheaves of $610, $37 for the rope. The first cost of the belt on such a drive would be approximately $895, and that of the rope some $250. The maintenance of the belt, at 5 per cent, would be $45 annually, and for the rope, at 8 per cent, $20 annually, making a total annual cost of $67 for the belt, and for the rope $57. These figures, if the distance of centers is reduced, would become more favorable to the belting, or if extended would favor the rope, but, as already mentioned, may be predetermined for any installation. The scrap value of rope is a considerably higher per cent of the first cost of the rope than is that of leather to its first cost, being about 15 per cent, while that of leather is about 10 per cent. These figures are of course susceptible of wide ranges, but are relatively close averages and in favor of the belt."

SAVING ROTTED TIMBERS of a decayed trestle has been accomplished by cutting away all the decayed wood at and above ground level and casting a solid concrete mass about the decayed part. The concrete is held in place by driving the hooked ends of vertical steel rods into the sound wood, both above and below the decayed parts, and fastening expanded metal to these from a point about 1½ ft. below ground level to a point 1 ft. above. —Engineering Record.



Letters from Engineers

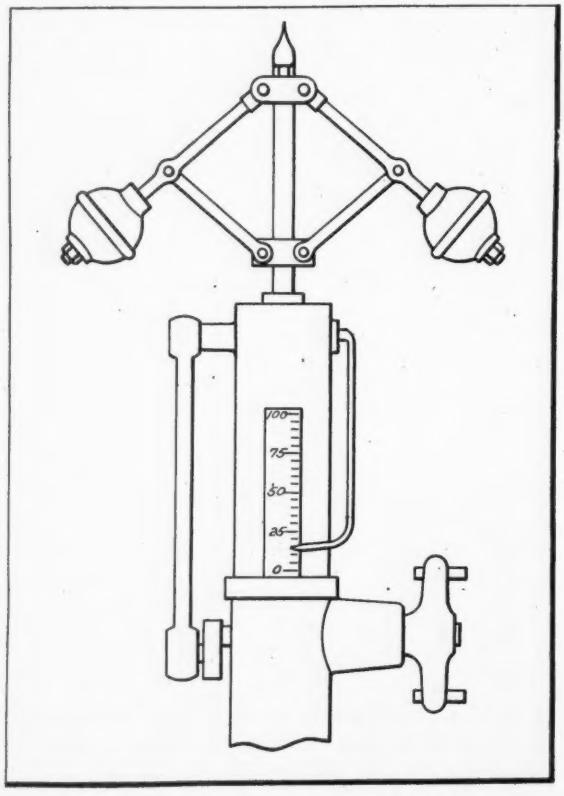
Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



AN ENGINE REVOLUTION GAGE

IN our plant there are 2 125-ton ice machines, direct connected to 2 Corliss engines. As it is necessary to adjust the speed of the engines, from time to time, according to the requirements of the load, we used to have to adjust the governor and then count the revolutions with watch in hand, sometimes 10 or 15 times a day. This made it very inconvenient so we made the device shown in sketch.

We screwed a graduated scale made out of a piece of steel plate on the side of governor stand and attached a ⅛-in brass rod on the steel block extending through the vertical slot in the stand. The brass rod was extended and so bent that its lower end pointed to lowest mark in the scale or zero when the engine is stopped.



ATTACHMENT TO INDICATE SPEED OF ENGINE

When the engine runs at its highest speed the pointer is at the highest mark on scale, which is 100. We ran the engine at different speeds, say 25, 50, 75 revolutions per minute, and in that way we graduated our scale. We graduated the scale between the space equally. All we have to do now is to look at scale to see what speed the engine is running. Edgar G. Schindler.

DIFFICULTY WITH SMALL STEAM PUMPS

EACH day I become more convinced that the small steam pump or boiler feeder is a much neglected piece of apparatus. This pump is one of the most wasteful or least efficient that there is anyway, and, if one is in use, it must have attention to keep it up to the mark. It is not an uncommon thing to find one of these pumps with one piston having a large groove cut in it so that the steam blows through at each stroke, and then we wonder where the pump gets such a short stroke. A new piston would cost possibly $1.50, yet the engineer will let the pump run on for months wasting steam of value more than this.

When in proper condition, however, a steam pump will run steady, so that if one does not run right, it is evident that something is wrong. Sometimes the steam piston does not even touch the cylinder surface, because they have been run so long that the entire tension of the steam packing rings is gone. The engineer, however, thinks that the small pump is all right as long as it keeps the engine and boiler running.

I remember an instance where 1 of the water valves had become loose and the seat was worn entirely out, leaving a large hole where the seat ought to have been. The pump had evidently been run a long time in this condition. I have also seen a small steam pump running, hammering badly, and opening the pump found that 1 of the water plungers had more than 1/16-in. play around them so that the piston was largely occupied in churning back and forth through the water in the cylinder, all the time, however, eating up steam and coal. If water valves are not in proper position, the pump will work badly and soon hammer itself to pieces. A small cut on the surface of one of the disks causes a leak that will get larger each day. Where soft valves are used, they can easily be trimmed with a file, but if the valves are of brass it is better to have them turned up in a machine shop.

One fault in attendance is to let the packing in the steam rod and stuffing box go as long as it will hold steam. This is a mistake, as the piston rod packing should be removed frequently. The lubricating qualities of this packing are soon exhausted, the packing becomes hard and will cut the rod, if screwed up tight enough to hold steam. The packing should be replaced often enough to keep it soft and pliable.

Another abuse of the pump is hammering in of water packing so that when steam is turned on the pump will hardly work. This is certainly unnecessary, as the pump will produce a vacuum on the suction without any such wedging of the packing, and packing driven in this way will not be as effective as if it were properly placed on the plunger. The packing should not be purchased too large and, if it is too small, a piece of cloth wrapped around the plunger will make the plunger work all right. Cutting packing down invariably ruins it.

Sometimes with pumps which have a brass liner in the water end held in place by a flanged collar, this liner will be found loose, allowing a circulation from one end of the cylinder to the other around the flange and inside the main body of the pump. This condition will make the pump rock and work badly, and it is difficult to find.

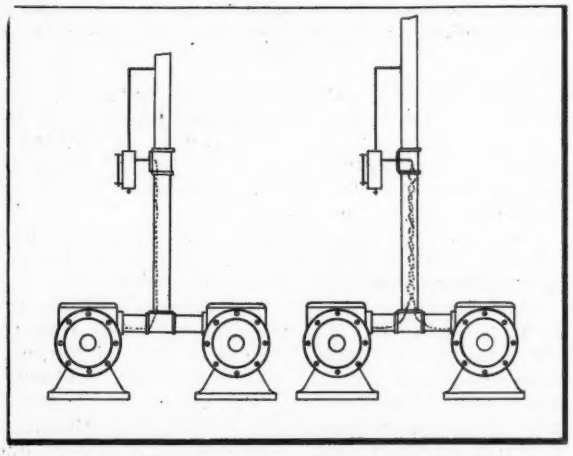
In some boiler feed pumps that I have examined, the water valves and plungers were in such bad condition that the steam end had hammered against the cylinder head and worn a cavity in the head covering. Attention given to examining the packing on pumps, water valves and plungers, and keeping the steam pistons in shape will extend the life of the pump many years, take much less steam and coal and increase the comfort and self-respect of the man in charge.

C. R. McGahey.

LUBRICATOR KINKS

N. W. DUELL, in Practical Engineer for October, page 698, submits a drawing showing a very valuable adjunct to steam engine lubricator. But as to the spoon shaped end of the discharge pipe, there is no advantage attached to any particular shape in this arrangement.

The writer experimented along these lines with various ideas 25 years ago. A piece of ⅛ or ¼-in. pipe tapped into the lubricator discharge, and of sufficient length to discharge the oil in or near the center of the steam-way, will do just as efficient service regardless of what shape the end may have, except that



PATH OF OIL BEFORE AND AFTER ADDING DISCHARGE TO LUBRICATOR

it is sometimes necessary, especially if the end of the pipe points upward, to file a groove in the bottom side near the end of the pipe, or twist a wire tightly around the pipe near the end, for the purpose of causing the oil to drop off, and not trail back the pipe, and go into the engine as before, thus defeating the intended purpose of the extended discharge.

This brings us to the why of this arrangement for feeding oil into the engine. In nearly all cases, the most convenient and accessible position to place the lubricator, is over the head end of the cylinder, and in the absence of an extension feed; the oil will trail down the inside of the steam-way, and all go to the head end of the engine, leaving the crank end without lubrication, making a constant source of worry.

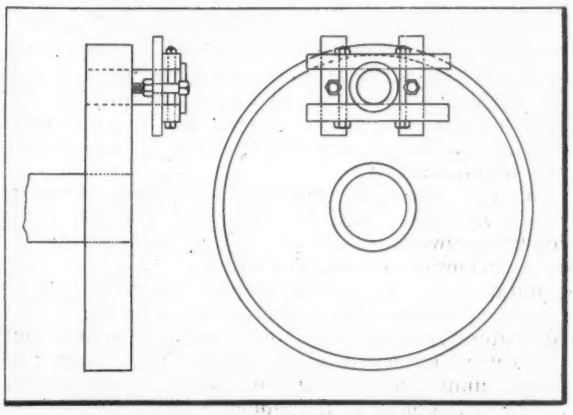
The same trouble will invariably result in a wrong position of a lubricator on a duplex pump, where the idea of an extended discharge to a lubricator first came to the writer. It occurred through an invitation from an engineer friend, to visit his plant for the purpose of examining a duplex pump; one side if which always worked badly. The steam pipe of this pump was 2 in., and the lubricator was placed about 18 in. above the steam chests, and a tee with ½-in. side-opening was used for a lubricator connection, and the position of the lubricator placed it squarely over the left side of this double pump, and watching that pump work from a head end view, I imaginied that I could see the oil from the lubricator trailing down the inside of the steam-way, and all going to the left side of the pump, which was working nicely, and the right side got none and worked badly. The idea suggested to me was, why not make the oil discharge into the center of the steam-way, and that idea was promptly acted upon by tapping out the discharge for a ¼-in. nipple of sufficient length to discharge the oil into the center of the steam-way, and that defect of the pump was settled for all time.

Many similar instances could be related to substantiate the benefit of this little addition to a lubricator discharge, and the writer has several times called the engineers' attention to this idea in the past years, through some of the engineering papers.

S. A. Smith.

REMOVING A CRANK PIN

THE sketch shows the way we forced a worn crankpin out of its socket. Our screw clamps were too narrow to slip over the crank disk, so after chipping the burr off we rigged up the press as shown, by screwing the bolts through the nuts considerable pressure was brought to bear on the rim of the pin by setting a piece of iron against the other end of the pin



METHOD OF REMOVING A CRANK PIN

and striking it with a sledge at the same time screwing up on the bolts the pin was removed without difficulty.

I have always known that a crankpin should wear mostly on one side but this was the first one we ever saw that the wear could be detected by the eye. The brasses on this pin were coned out to a point within about ⅜-in of the ends and about 2-3 of the circumference of the half brass and filled with babbitt, for a bit we could not figure out why the pin had worn so much faster where the softer metal came in contact with it but concluded it was on account of the particles of grit being imbedded in the babbitt and acting as a cutting tool.

In driving the new pin home it was made a good driving fit and smeared over with white lead and sent

home in good shape with a sledge and piece of iron. I do not believe it will come loose, of course with pins of a larger size it would be necessary to force them in with a press or make a shrink fit of the job. The wear of this engine is excessive, due to the grit from a dry cement floor over which heavy trucks are run all day, grinding the surface into a powder which finds its way into the bearings. Knowing that the engine would be in an exposed place in a department we would have preferred one of the enclosed type but could not locate the 2 drive wheels properly on such an engine. A cement floor looks well and is easy to keep clean, but the gritty dust arising from it unquestionably cause excessive wear on machinery, especially where the floor is dry and there is much traffic over it. In an engine room it is generally oil soaked which makes it less destructive. This kind of floor is not more durable than wood and is a source of discomfort to the operators who have to stand on it. Also it used to worry us and cause the superintendent to look sour when we would have to break it up to get at pipes buried in the floor. But we are overcoming this as opportunity offers by putting in tunnels with suitable manholes. Pipes last much better in tunnels and are accessible for repairs. The floors in this shop have been dug up often enough to pay for a most elaborate set of tunnels. We believe that if we were laying out a shop the size this one now is, we could arrange a series of tunnels that would take care of the piping and electric wires, but in this case there has been a growth of 1000 per cent and it is hard to dig a hole anywhere about the place 3 ft. deep without striking a pipe.

J. O. B.

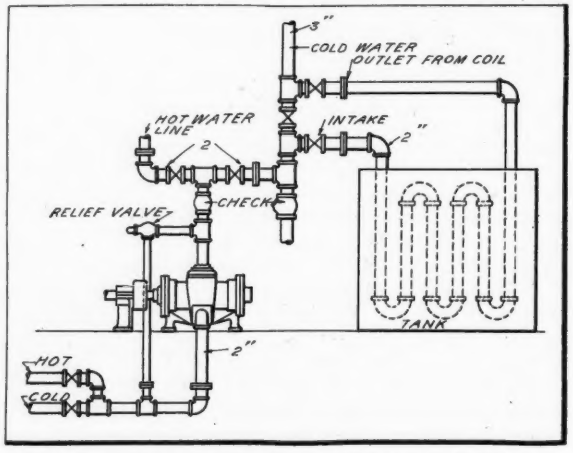
PUMPING HOT AND COLD WATER AT THE SAME TIME

MOST all office buildings that are 12 or more stories high have to have their own pumping plants to supply water at the top of the building, as in most cases the city pressure is not strong enough to reach the top floors, and as all buildings are supplied with both hot and cold water service; and in most cases, drinking water, it usually requires 2 or 3 sets of pumping outfits.

In our particular building, a 14 story structure, which has been built 10 years, we have the usual complete power equipment. The generating plant being gas engines instead of steam. The house service pumping plant first installed was 2 duplicate triplex pumps motor driven by reducing gears for the hot and cold water service, and another smaller triplex pump belt driven for the drinking water. The 2 larger duplicate pumps were taken out after a year's service owing to the noise of the reducing gears, and replaced by 2 Worthington turbine centrifugal pumps. A small duplex steam pump was also set up to be used for emergencies. Two of these pumps, the steam, and one turbine were connected to both the hot and cold water lines, and the other to cold water only, so that they could be used either way in case of repairs.

About a year ago it happened while doing some repair work to the steam pnump, the motor on the cold water pump gave out, leaving only one pump for service, and as it was necessary to keep up both supplies, the remaining pump was opened up to both lines and the hot water was pumped both ways. The hot water, being the overflow jacket water from the gas engines, was usually kept at about 125 deg., this occuring in the winter time, it was noted that if the water was not drawn too fast on the cold water line, the hot water would become quite cool. This brought up the question as to why the hot water would not continuously answer the purpose of the cold water if it could be partly cooled before pumping it through the building.

The overflow of the gas engine jacket water was much more than what was needed for the hot water service alone, the remainder going to waste to the sewer; therefore if more of it could be used it would be a saving in water consumption. As it was becoming necessary to install a new pump for the house service, we decided to make it large enough to supply both lines. A large 2500-gal. tank in a corner of the engine room was installed for an emergency supply



ARRANGEMENT FOR SUPPLYING HOT AND COLD WATER WITH ONE PUMP

to the house line. We planned to couple the new pump to both lines and then by-pass the water for the cold water line through a series of pipe coils looped in this tank, which would be kept full of cold water, by this we hoped to cool the water sufficient to make it serviceable for the cold water line.

As shown by the sketch, a valve with a tee each side of it was placed in the 3-inch supply line, the tees having 2-inch openings. From the lower tee a 2-in. line was run into the tank and a series of loops run up and down in the tank and then returned to the tee above the valve. There being over 80 ft. of 2-in. pipe submerged in the tank. The new pump, a Quimby screw pump, was installed. The suction was branched with a tee and coupled by a 2-inch line to both hot and cold water supply. The discharge, a 2-in. line, was also branched and one side was run direct to the hot water service line, while the other was connected to the lower end of the cold water service line and by closing the valve between the coil connections and opening the 2 valves on the coil lines, the hot water would be pumped into the lower end of the house line and then up through the 80 ft. of cooling pipe back into the house line above the valve.

There being valves on both suction and both discharge lines, cold water could also be pumped direct by cutting out the coil and opening the valve in the house line. After this system was completed and tried out it was found that the water passing into the coil at about 125 deg. was cooled to about 85 or 90 degrees, and by the time it reached the point of use was sufficiently cool that the difference from the old way was not noticeable.

This system was used during the past summer and is in use at the present time, the water in the

summer reaching the point of use at about the climatic temperature, while in winter is pleasanter, as the icy chill is taken off. Not only was this a large saving of water, but there was also a saving in power. The Quimby pump was equipped with a 3-hp. motor, which handled the pump easily, while formerly the 2 turbine pumps, each equipped with 7-hp. motors, both had to be run, thus making a 3-hp. motor do the work that 2 7-hp. motors had been doing.

L. M. Johnson.

PUMPS FOR RETURN

IN regard to the article headed as above, in the December issue, I would say that judging from the data A. C. G. furnishes, I do not think it necessary to dig a pump pit so deep. I am operating a blast heating system at the present time where there is but 1 ft. between the suction of the pump and the bottom of the coils. The pump should have a cold water connection on the water end to condense any steam that may come back with the return, also to make up for steam and water lost.

I have had considerable experience with Marsh pumps for that kind of service and I would recommend that make. The Marsh pump I am using has a small lever attached to the side of the valve chest, the mere turning of which will deflect the exhaust steam either into the atmosphere or into the suction pipe, thereby using the returns as condensing water and maintaining a partial vacuumn to help the pump along.

He does not say whether the engine is single or compound, therefore we have to guess as to the possible amount of steam consumption. Using 20 lb. per horsepower, which is a low rate for small engines, we get 40+20=800 lb. of water per hour, which the pump would have to handle. A pump 5x3x5 in. would handle that amount of water and would be a great help in reducing the back-pressure on the engine.

Unless circumstances and lack of space prevent a lower level, I see no reason why the receiving tank should be 20 ft. above the pump. Fred L. Wagner.

QUEER ENGINEERING

I KNEW a man who owned a threshing outfit. One fall, when he wanted to start in a hurry, he sent for the engineer and while waiting for him to come, had a bright idea. "Come on boys," he said; "let's fill the boiler while waiting, then Elmer can get up steam in a hurry."

Jumping on top of the boiler, he had the men passing him buckets and was busily pouring water down the smokestack when the engineer arrived.

Two boilers were being installed, and the boiler inspector and engineer who was to have charge of them were talking about how much pressure to allow. The boiler inspector said 100 lb. per sq. inch was the proper pressure to be carried.

"Well," said the engineer, "if I set each pop at 50 lb. that will be 100 lb. in the two."

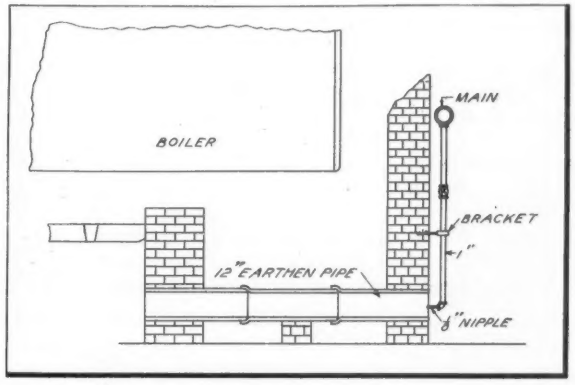
Subscriber.

BURNING NO. 3 BUCKWHEAT COAL

WE often read of the unnecessary wasting of the gases that are given off coal in furnaces. The following method of burning these gases means a saving of about 15 per cent of the coal burned:

In the first place, grates of the pinhole type are used, with about 60 per cent air space. The dampers should be about quarter open so that the gases will burn before they reach the stack. Good results are obtained with a blower of the jet type. It is placed in the back wall of the boiler and is easily made from a 1 by ⅛-in. bushing, with a ⅛-in nipple about 1½ in. long. The bushing is screwed in an elbow on the end of the supply pipe. A 12-in. earthern pipe leads from back wall to the ash pit for the air.

When burning No. 3 buckwheat coal it should be spread very thin and often, covering all spots. Green coal should not be thrown on live coal that is not incandescent. It should be leveled off with a light hoe or level. A level can be made out of a piece of ⅜ or ½-in. pipe the length of the firebox, with a malleable iron tee on the end, with 2 6-in. nipples screwed in the ends. When burning No. 3 buckwheat and soft



BLOWER FOR BURNING FINE COAL

coal it should be mixed 10 parts hard to 1 part soft, which does away with smoke if it is burned as above.

G. A. G.

UNSTEADY MOTOR LOAD; GOOD SWITCH CONTACT

HERE is the writer's experience with an I. T. E. circuit breaker controlling a motor circuit. A 25-kw. generator was used to run a 20-hp. motor with the breaker set at 200 amp. This was a shunt dynamo used to drive motors for cutting logs in 4-ft. lengths, giving a variable load from 0 to 200 amp. Large logs were continually opening the breaker. I did not wish to compound the dynamo, so this is how I solved my problem.

I placed on the main shaft to the motor a flywheel 4 ft. diameter with a rim 3 in. sq. It helped some. I then placed another (from the scrap) of similar dimensions, with like results. I then had one made 9 ft. diameter with 10 in. sq. rim. Using the motor controller or starting box, I found it took me 1 minute to get the flywheel up to speed. Cutting in quicker would of course open the breaker. My ammeter, when no load was on the saw, read 140 amp., full load 140 amp., the momentum of the flywheel did the work. I had no further trouble cutting small logs, large logs, no logs, my load was practically constant.

This continual opening of the circuit breaker at first, led me to a remedy for knife switches giving trouble from cutting or freezing. One in such condition that the spring will not release is no better than none.

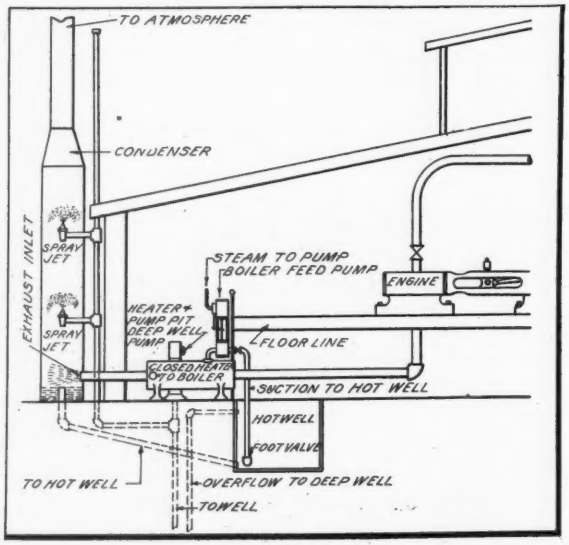
These contacts soon became damaged in this manner. I filed them smooth. Having to resort to this filing so often I found my carbon contacts red hot, showing they were carrying most of the load. Repeated filing only increased my trouble. I got out

of it by replacing the knife contacts with new ones, then with the current off, I used a mixture of flour of emery and engine oil and painted the knife contacts. I then opened and closed the circuit breaker, say a dozen times, wiped it clean and had a ground joint.

This is a salt plant and the action of the salt brine, gases and air, quickly tarnishes copper, giving it an insulated surface. My switches on the board are all over loaded and by applying this method to them, I can run my switches to double their rated ampere capacity with no rise in temperature. A simple remedy but valuable to one working under similar conditions. Wm. Newman.

SHORT WATER SUPPLY

IN a certain small flour mill plant water was very scarce. The supply was drawn from a deep well, which would run dry about noon. Water being hauled by a team and tank to complete the day's run. The owner could not well afford to install a condenser and cooling-tower. So the engineer adopted the following scheme. Twenty feet of old smokestack was turned off straight and smooth at each end, and one end had a head riveted to it. The other end had a cone shaped section riveted to it reducing it to 6 in.



CONDENSER ARRANGED TO SAVE WATER

in diameter, then a 4-ft. section of sheet metal pipe was riveted to the top of cone. The stack was then erected in a vertical position just outside of engine-room.

The exhaust steam after passing through a closed heater was piped into the side of the stack about 2 ft. from the bottom. The discharge from the deep well pump was piped to a stand pipe along side of the "smokestack condenser," and was connected by means of 2 tee fittings to 2 spray jets. Thus the exhaust steam rising slowly through the jets of cold water was condensed and drained into the hot well. The boiler feed pump drew the water from the hot well and pumped it through the heater to the boiler. Of course, as the quantity of water flowing to the hot well was greatly in excess of what the boiler required, an overflow had to be provided, and water overflowing from the hot well went to the deep well.

This arrangement would not save all the steam. But it made it unnecessary to team any more water and saved the expense of a man and team.

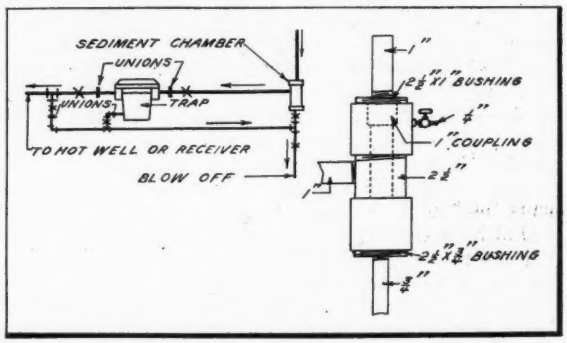
The sketch will make the details plain; the high standpipe is necessary in order to get a steady pressure on the jets. Chas. Fenwick.

PROPER INSTALLATION OF STEAM TRAPS

THE importance of thorough drainage of steam pipes of water resulting from condensation of steam is not always recognized, hence accidents have resulted in some cases. To insure high efficiency, steam traps must be installed to drain all steam pipe lines.

A steam trap should be installed in the steam supply, and connected up with a sediment chamber, also a condenser. A large amount of trouble can thus be saved by preventing chips of iron or rust, particles of dirt, scale, etc., from entering the steam trap and clogging up the valves and interior mechanism of steam engines and pumps. The sediment chamber must be blown off frequently, in order to keep it free from sediment.

Where there is danger of the sediment chamber becoming steam bound, this is remedied by opening



STEAM TRAP ARRANGEMENT AND DETAIL OF SEDIMENT CHAMBER

an air cock for a short time which is located at the top to let off any accumulation of steam which may be confined there under pressure.

Lewis A. Danner.

TECHNICAL OPINION

IN Practical Engineer for Jan. 1, the following question was published: "What is the best method to get a cat accustomed to a power house, so that she will not yowl in synchronism with the alternator and cause eddy currents between the smokestack and the ashpan?" Also "Our cat sings so that the overtones and harmonics are producing surges on the line."

The writer is very much surprised to learn that the chief engineer of a large power house should find it necessary to go outside his own plant to have such a very simple matter settled. The writer having had a similar experience offers the following advice.

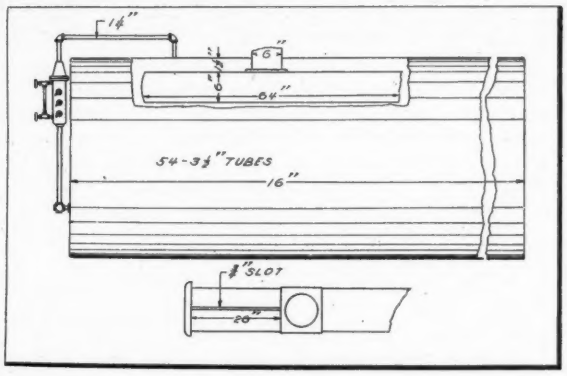
Over-excite the feline field, thus reducing the angle of log and raising the power factor which will have a tendency to restore the harmonics to an equilibrium.

If the line surges still continue, attach a choke coil to the grimalkin larynx, and put a Pupin coil in series with her spinal column. The eddy currents between the smokestack and ashpan are sometimes caused by an open damper. The remedy is to close the damper, open the combustion chamber doors and turn on the forced draft.

T. N.

A QUESTION OF WATER COLUMN CONNECTION

HEREWITH is a rough sketch of a boiler, the connections of the water column of which I do not think are as they should be. The steam connection is within 1½ in. of the slot in the dry pipe and is in line with this slot. Our chief says that it is all right, but I think that when the boiler is forced, it will



CONNECTION OF WATER COLUMN WHICH IS QUESTIONED, AND DETAIL OF DRY PIPE

show more water in the water glass than is in the boiler. I would like to hear the opinion of other engineers on this point. H. S.

GLYCERINE AS LUBRICANT

ONE of the engines in a plant in which I worked was a large Corliss, 1 or 2 of whose dashpots gave some trouble frequently. Several remedies were tried but it was finally concluded that the neat's foot oil which was used to lubricate the pot caused the leather cup to get too soft, thereby letting air pass it.

The chief was advised to use pure glycerine as a lubricant. It had been used for about a month, when its effects showed up very unexpectedly. The engine was shut down daily at noon for 35 minutes. This day, when the engine was almost stopped, a violent vibration in the low-pressure valve gear was noticed; upon making an examination the pot seemed very badly scored. The sides of the pot were drenched with oil, and we rubbed the grooves with it, trying to work the oil down between the plunger and pot. After being rubbed for a moment or so, the grooves started to disappear. It was then discovered that the cuts were only hard glycerine which had been caked by the heat. The other pots were examined and found grooved also but not so badly. It is needless to say that the use of glycerine was discontinued and neat's foot oil substituted, but in very sparing quantities, which did away with our trouble with the dashpot leather failing to act as it should. Fred L. Wagner.

A PECULIAR BOILER ROOM ACCIDENT

IN a steam heating plant the fireman had a bar made of extra heavy pipe with one steel-pointed end. The bar was used for general firing purposes and when overheated was thrown on the coal pipe. Coal entered the open end of the pipe and gradually filled it. When the original steel point wore off the bar was sent to the blacksmith and a new steel point was placed in the opposite end without removing the coal from the pipe. After a few times using it split open for about 4 ft. of its length accompanied by a violent explosion which shook the house near by. F. T. Ruffener.

SMALL NEGLECTS—AND CONSEQUENCES

HERE is a new type of vacuum breaker installed on the jet condenser of a 4500-hp. Corliss engine in a steel mill.

The engineer received a signal to stop and closed the throttle. Before the engine stopped, the valve stem on the vacuum pump broke, stopping the pump. There was a vacuum breaker on the condenser, operated by a float. This float was water logged and failed to work. The low-pressure cylinder, which was 66 in. in diameter, picked up the injection water, breaking steam valves, and bending the key in the intermediate crosshead, so that it had to be drilled out.

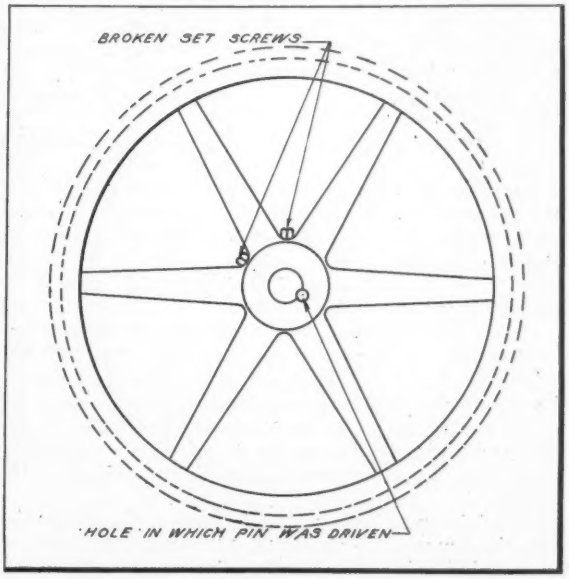
The vacuum breaker could be removed by taking out some small top bolts, but the master mechanic and chief engineer did not bother with a little thing like that.

A hole for 1-in. pipe was tapped in the 28-in. exhaust pipe just after it left the cylinder, and a connection made through a valve, placed near the throttle, to the steam main.

When the engineer received a signal to stop, he was to open the 1-in. valve before closing the throttle, and leave it open until the engine stopped. The same when starting up, opening the valve before the throttle and leaving it open until the engine was up to speed. The idea being to blow back any water that attempted to rise in the exhaust pipe. The Oiler.

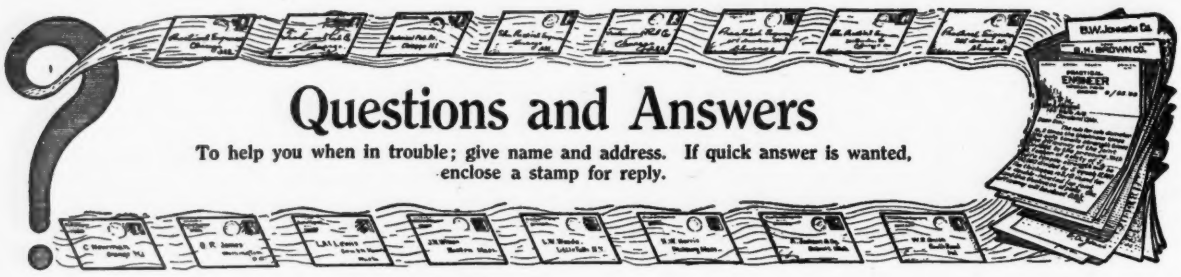
FASTENING A GEAR

HERE is a job that I recently did, and it is giving entire satisfaction. A drive gear on a steam mangle was held to the shaft by 2 set screws, these screws continued to work loose, and wore a groove around



GEAR WHEEL TROUBLE AND REMEDY

the shaft so the gear could not come off when the set screws were loosened. In continually tightening the set screws they were finally broken off low down and could not be taken out. I took a ratchet and a ½-in. drill and drilled a hole in the end of shaft and line of the gear, cutting half out of each; this hole was cut 2 in. deep and a pin that fit the hole tightly was driven in. This cured the trouble permanently, since we have had no more trouble with it. R. L. Campbell.


Questions and Answers
To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

ANSWERS TO THE CHIEF ENGINEER'S CATECHISM VIII

By Fred L Wagner

IN my opinion the best oil burning furnace is one where the air entering at the ash pit doors, is caused to come in contact with the heated bricks which cover the grates. The fire bricks covering the grates should be laid end to end, in rows 3 or 4 inches apart, and these in turn should be covered by more fire brick laid close together. The air coming in at the ashpit doors passes to the rear of the pit, up through the spaces between the bricks, into the furnace at the oil nozzles. This preheated air facilitates good combustion. There is no need of a bridge wall in an oil burning furnace, in fact, it would be detrimental to the boiler, because the white hot flame being thrown against the wall would be deflected up, against the shell of the boiler, which would concentrate too much heat in one spot, thereby injuring the plate in time. The floor of the combustion chamber may be raised to the level of the bottom of the grates, and covered with firebrick, thereby presenting a large area of surface to receive the intense heat and aid in the combustion of the gases before they reach the tubes. In a properly constructed oil furnace the distance from the shell to the grates is about the same as in a coal burning furnace.

2. In using natural gas as a fuel under boilers, a ratio of 1 cu. ft. of gas to 15 cu. ft. of air is used, which provides for a 50 per cent excess of air above the amount of air theoretically needed for the complete combustion of the several elements, of which the gas is composed.

3. A comparison of heat values of natural and producer gas is as follows:

1000 cu. ft. Natural gas contains 1,000,000 B.t.u.

1000 cu. ft. Producer gas contains 150,000 B.t.u.

which discloses the fact that natural gas is far superior to producer gas in heat value, and a comparison of their efficiencies as steam producers under boilers, will show natural gas as far superior to producer gas, as it was in a comparison of their respective heat values.

4. The calorimeter is an instrument used to measure the amount of moisture in steam. As there are 2 or 3 kinds, I will describe the action of the most common, vis., the barrel calorimeter.

A perforated pipe usually ½ in. in diameter is inserted into the steam supply pipe near the boiler, a hose is connected to the pipe and reaches to a barrel containing water, standing on a scale so that the water may be weighed. The hose and pipe must be thoroughly insulated with felt covering. After weighing the water and barrel and noting the temperature of the water, steam is allowed to pass through the pipe and hose to warm them. When they are thoroughly warmed, the end of the hose is suddenly thrust into the water and left there until the temperature of the water reaches about 110 deg. F., then the hose is withdrawn quickly and the temperature and weight taken again. The percentage of moisture in the steam is determined by using the following formula:

Per cent of moisture=1—Q.

$$Q=\frac{1}{H-T}\left(\frac{W}{w}(h_1-h)—(T-h_1)\right)$$ in which

Q=quality of the steam, dry saturated steam being unity.

H=total heat of 1 lb. steam at the observed pressure.

T=total heat of 1 lb. water at the temperature of steam of the observed pressure.

h=total heat of 1 lb. condensed water, original.

h_1=total heat of 1 lb. condensed water, final.

W=weight of condensing water corrected for water equivalent of the apparatus.

w=weight of steam condensed.

5. In designing a feed-water heater the rate of evaporation of the boilers it is to supply should be taken into consideration so that enough heating surface can be provided if it is a closed heater, for the water to pass over and become heated to as near 212 deg. F. as possible before entering the boiler. An allowance of ¼ sq. ft. of heating surface per boiler horsepower is generally allowed for this style of heater. If an open heater is designed for a plant, not only the quantity of water must be figured on but the quality also, by this is meant, the amount of mud and scale forming ingredients must be determined and the sizes of the pans in the heater are figured as follows per 1000 lb. of water handled per hour.

Muddy water, 8.5 and 9.1 sq. ft.

Clear and pure water, 2 and 2.2.

6. I would recommend that copper or brass tubes be used in closed heaters, because tubes made of those metals are not as subject to corrosion as those made of iron.

7. In designing a pump, the velocity of the water passing through the valve openings and pipes should be kept down to about 250 ft. per minute. Many manufacturers allow a ratio of about 2 to 1 between the water piston area and the sum of the suction and discharge valve areas. Duplex pumps usually have a ratio of 1⅓ to 1 between the plunger area and suction opening area and a ratio of about 2 to 1 between plunger and discharge opening areas.

8. In determining the size of the steam outlet of the boiler, the weight of steam to be discharged per hour and its pressure must be known. Then proceed with the following formula and the diameter of the opening can be found:

$$D=\sqrt{\frac{0.0004\times WV}{0.7854}}$$ in which

D=diameter of opening.

W=weight of steam per hour.

V=volume of pound of steam at given pressure, as found in steam tables.

9. The fundamental use for a trap is to drain steam systems of the condensation periodically without allowing any steam to escape.

Therefore I would place a steam trap at the lowest point in a system or, where any pockets were formed; in which, the water would accumulate in such amounts as to cause serious damage to the pipes if not removed.

10. The safety valve on a boiler should be attached to the steam dome, the top of which is usually 3 or 3½ ft. from the level of the water. In placing it there the danger of siphoning the water out of the boiler, when the valve opens, is reduced to a minimum.

A short nipple of the same size pipe as the valve should be screwed into a flange which has been riveted around the safety valve opening in the dome. The valve should be secured to this nipple by means of a flange union, so that the valve may be removed and a blind flange substituted when a hydrostatic test is to be made.

By F. Wells

1. I prefer a furnace with a large combustion space and considerable length. This would allow plenty of travel for the sprayed fuel and the combustion gases, thereby providing for a good intermixture of the gases, and consequently, good combustion. This would also prevent the flame from coming into direct contact with the heating surfaces, and thereby, making local overheating less liable. The furnace should be well covered with fire-brick and the fronts fitted with louvers, in such manner, as would provide for an efficient air-supply.

2. Haswell says: To effect combustion of 1 cu. ft. of gas, 2 cu. ft. of oxygen are required; and, as 10 cu. ft. of atmospheric air are necessary to supply this volume of oxygen, 1 cu. ft. of gas requires oxygen of 10 cu. ft. of air. Thus 10 cu. ft. of air are necessary for the combustion of 1 cu. ft. of gas.

3. Approximately 30,000 cu. ft. of natural gas have the heating power of 1 ton of coal. From experiments 131,280 cu. ft. of gas have been produced from one ton of coal and in the process of gasification and purification there was a loss of about one-third. Calculated on this basis, the comparison would be in the favor of natural gas in the ratio of 5.8 to 1.

4. An instrument called the calorimeter is used to determine the amount of moisture in steam. The barrel or tank calorimeter is the simplest form of this instrument which has been employed. It consists of a strong barrel or tank of hard wood, absorbing little of either water or heat, and having a movable cover. This tank is mounted on platform scales capable of accurate adjustment and having as fine readings as possible. It is filled with water to within ¼ its height from the top, and the steam is led into it through a rubber tube or hose of sufficient capacity to supply steam to the amount of 1/8 or 1/10 the weight of the water in 3 to 5 minutes. A steam gage of known accuracy gives the boiler pressure, and the corresponding temperatures and total heat of the steam are ascertained from the steam tables. In using the apparatus the steam is rapidly passed into the mass of water contained in the tank, until the scales show that the desired amount has been added. The steam is directed by varying the position of the end of the hose, and by inserting it so deeply in the water that the whole mass is thoroughly stirred, and a perfect intermixture of condensing water with the water of condensation secured, so that the temperatures indicated by the inserted thermometers shall be the mean temperature of the mass. The weights and temperatures are then insertd in the log of the trial and the proportion of the water brought over by the steam is easily calculable.

5. Determining the size of a feed-water heater, it is first necessary to determine the amount of water needed to supply the boilers, working at their maximum capacity. As an evaporation of 30 lb. of water is equal to one boiler horsepower, then, the boiler horsepower being known, it is a very easy matter to determine the size of the feed-water heater necessary. The manufacturers, by using the boiler horsepower for a standard, can produce a heater at a moderate price, due to making a large number of standard sizes.

6. I would recommend that all tubes, coils and sheets be made of brass, the sheets and tubes or coils being made from the same composition of material. My reason for this, is that brass stands the corrosive effects of water much better than iron.

7. F. W. Dean in the Engineering News, says, if the area through valves and water passages are sufficient to give a velocity of 250 ft. per minute or less, they are ample. The water should be carefully guided and not too abruptly deflected. The approximate size of suction pipe, where the length does not exceed 25 ft., and there are not more than 2 elbows, may be found as follows: 7/10 of the diameter of the cylinder multiplied by 1/100 of the piston speed in feet. For duplex pumps of small size, a pipe one size larger is usually employed. The velocity of flow in the discharge pipe should not exceed 500 ft. per minute. The volume of discharge and the length of pipe vary so greatly in different installations that where the water is to be forced more than 50 ft. the size of discharge pipe should be calculated for the particular conditions, allowing no greater velocity than 500 ft. per minute. The size of discharge pipe is calculated in single cylinder pumps from 250 to 400 ft. per minute. The use of the plunger area to determine the size of discharge and the area of valves would only be used in determining the velocity of flow.

8. The formula governing the U. S. Inspectors of Steam Vessels is A equals 0.2074 times W divided by P. Where A is the area of valve in sq. in. per sq. ft. of grate surface W is weight of water evaporated per sq. ft. of grate surface per hour and P is absolute pressure per sq. in. When this calculation results in an odd size of valve, use the next larger size of valve. Example:

Boiler pressure 70 lb. (gage).

2 furnaces: grate surface equals 2 times 5 ft. 6 in. (long) times 3 ft. (wide) or 33 sq. ft.

Water evaporated per sq. ft. of grate equals 100 lb.

Hence 0.2074 times 100 divided by 90 equals 0.2304.

As there are 33 sq. ft. of grate surface, then the area of the valve would be 33 times 0.2304 or 7.6032 sq. in. For which the diameter is 3⅛in. nearly.

9. Steam traps should be placed at any convenient place under the steam line and the drain pipes should be attached to the lowest point in the steam line or at places where pockets are formed. The water settling at these points will thus be carried off.

10. Safety valves should be placed at the highest point of the steam drum, and where possible, should always be placed in a vertical position. By placing the safety valve in this position the surplus steam is taken care of without any serious effect on the water level in the boiler.

By S. C. Singer

6. Experience has shown that nickeled brass tubes on account of their high rate of conductivitiy, elimination of scale deposits and cost are the most applicable for use as coils or tubes in a closed heater.

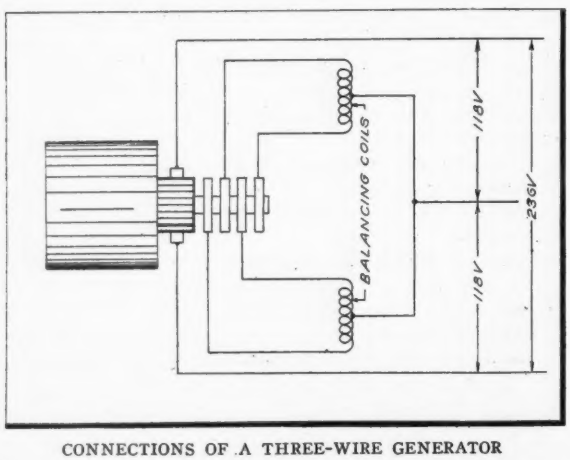
9. All steam mains should drain in the direction of the flow of the steam. At points where the direction must be changed, due to obstructions, etc., a tap must be made and a pipe run from this to a receiving tank. The fewest of these changes of direction or traps made necessary of course is the better.

The drips from all steam mains should lead to this receiving tank and the condensation should either be automatically pumped back to the boiler under pressure or drain by gravity. In the first case a return trap should be used. A return trap should be located a couple of feet above the boiler, according to the steam pressure so that the trap may empty by gravity. The various drips are lead into a manifold which is connected to the trap. In some traps the water upon reaching a certain height releases a weight which opens a steam valve. The equalizing of the pressure in the trap and boiler allows the water to flow into the boiler. Check valves are used to prevent reverse flows.

10. In locating a safety valve always place it as close to and above the boiler as possible. It is best to place it at the boiler and carry away the escaping steam through an open pipe rather than have the pipe between the valve and the boiler. The main idea is, of course, to have the steam act on the safety valve before it reaches the main steam piping. It should be accessible at all times.

A Three-Wire Generator Trouble

IN the place where I am employed as engineer, there are 3 150-kw., 118-236 volt Westinghouse 3-wire generators. Two of these machines run quietly and without sparking. The third one makes a loud humming noise similar to an alternator and flashes at intervals. The average load is about ¾ the full load capacity of the generators. The spark is a bright yellow and seems to occur nearly midway between the brushes.



CONNECTIONS OF A THREE-WIRE GENERATOR

The commutator is sand papered frequently and is in good condition, there being no high bars nor flat spots. Shifting the brushes has little or no effect on the sparking. At times there is no sparking for 5 or 10 minutes, then a single spark will appear to go from one brush to the other. Will some of the readers kindly give their opinion of the cause of this trouble?

In this type of machine the regular 2-wire generator is used to supply current to the outside wires of a 3-wire system. The generator is supplied with slip rings connected to the armature in the same manner as for a 2-phase rotary converter. These rings are much lighter than they would be for a converter as they only carry ⅛ of the generator load. The rings are placed at the end of the commutator and connected directly to the commutator bars. The balancing coils are built of standard transformer parts, and are placed in cases similar to those of ordinary small transformers.

The coil has a straight continuous winding, both ends and one tap from the middle point of the winding being out of the case. Two coils are used with each generator and are connected to the slip rings, one across each phase. The taps of the middle points of the coils are connected together and to the neutral wires of the system. The accompanying diagram shows the connections. J. C. H.

Connecting 2 and 3-Wire Systems

SHOULD like to know if I can connect a 2-wire system to a 3-wire system and run it in case of emergency. Have a large 3-wire system and a small 2-wire system.

A. A 2-wire system having the same voltage as one side of a 3-wire system can be thrown onto the 3-wire on one side, but it will, of course, produce a considerable unbalancing in the 3-wire system, and you should be certain that the balancing coils or motor generator, or whatever is used to equalize the load between the 2 sides, has sufficient capacity to take care of this unbalancing. The efficiency will not be quite as good for the 3-wire system as with a balanced load, but very likely the efficiency of the plant will be better than running a small separate generator for the 2-wire system.

Catch Question

IF you were to take charge of a Corliss engine, how would you know whether the governor was large or not? You are not to take any measurements, but tell by looking at it. Is this possible, or is it just one of the so-called "catch questions"?

F. K.

A. The velocity, radius, weight of balls, and tension in the spring are all factors in the design of a governor, and are so proportioned that their forces are in equilibrium when the engine is running at normal speed. Not knowing anything of these quantities, it would be impossible to tell anything about a governor by mere observation.

If the engine were known to race, or slow down abnormally, it would be logical to look for trouble in the governor. If the engine runs perfectly, it is logical to assume that the governor is the proper one for its place.

Horsepower of 2 and 3-ply Belting

WHAT is the horsepower of a 2-ply belt, also of a 3-ply belt, running over pulleys with dimensions given below, and at what load would these belts become dangerous: Belt width, 39 in.; diameter of flywheel, 192 in.; diameter countershaft pulley, 96 in.; distance between centers, 24 ft. 5 in.; arc of contact on flywheel, 28 ft. 11 in.; on driven pulley, 11 f. 9 in.?

F. M. P.

A. Prof. Bird gives as result of experiment that on a 2-ply leather belt the total load permissible is 150 lb. per inch of width, and the difference in tensions between the tight and loose sides should be 70 lb. per inch of width. For a 3-ply belt the total load is 150 lb. per inch and the difference allowed 100 lb.

You do not give the speed at which your pulley is running, but assuming 100 r.p.m. as the speed of the 96-in. pulley would give belt speed of 2513 ft. per minute. The circumference of the 96-in. pulley would be 301½ in., and with a contact of 11 ft. 9 in. this would give as the belt arc

$$\frac{360 \times 141}{301.5} \text{ or } 168.5 \text{ degrees.}$$

In a table for angular contact we find that the power transmitted with this arc of contact is 97 per cent for 170 degrees, or, say, 96.5 per cent for 168.5 degrees.

Prof. Bird states that in order to meet the tensions which he has found desirable, a double belt 1 in. wide at 470 ft. belt speed a minute will transmit 1 horsepower, and a triple belt 1 in. wide at 320 ft. a minute will transmit 1 horsepower.

We should then have for your belt at a speed of 2513 ft. a minute, 2513 ÷ 470 times the arc of contact factor, 0.965, times the width, 39, which would give 203 as the horsepower for double belt. For triple belt it would be $\frac{203 \times 470}{320}$ or 288 horsepower.

As to the load at which these belts would become dangerous, this would evidently be when the tension was increased to the danger point. The breaking strength for double belt is about 400 lb. per inch of width, and for triple about 580 lb. The danger point would come probably where the strain on the belt is ½ the breaking strength, because leather is so variable in its strength that the weakest point in a belt might very likely have a strength not over half the average. This would give for the 2-ply belt a load about twice the normal, or 400 horsepower, and for the triple belt about 550 horsepower.

Boiler Room Problems

WHAT kind of boiler would you use where vibration is great?

2. What is stage expansion.

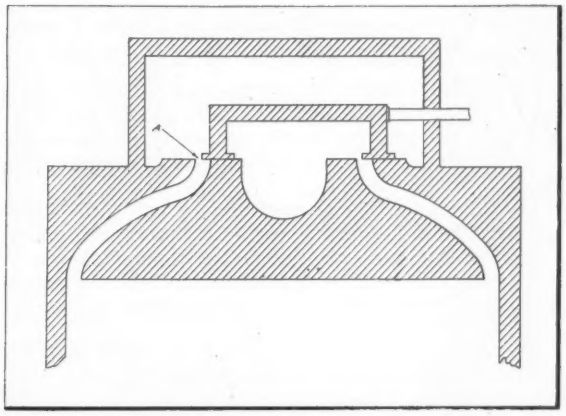
3. What is inside lead.

4. Where is a fusible plug placed in a watertube boiler? F. S.

A. We do not quite understand what you mean by vibration being great. If you mean in some place where the boiler itself is subject to great vibration, a cylinder or Lancashier boiler is best, because there are less joints to be loosened by the vibration. If you mean that vibration in the steam pipe is great, it makes little difference what kind of a boiler is used. The only thing is to get good-sized steam space so to cut down the tendency of the steam to produce vibration. A large steam drum in a water-tube boiler or a fire-tube boiler with a good-sized steam dome will help here.

2. "Stage expansion" is a term used in regard to steam turbines. In one form of turbine the steam is expanded through a nozzle from boiler pressure to exhaust pressure, and this steam at high velocity is thrown against the blades of a revolving wheel. In another type the steam is expanded gradually, passing from moving blades to fixed blades whose length and area increase gradually. The stage expansion turbine is a combination of the two. Where high steam pressure is used and expanded to high vacuum, it is found uneconomic to expand it through a series of blades and the expansion is, therefore, divided into a number of steps. The steam is passed first through a set of nozzles which expand it from boiler pressure down to, say, 25 lb. This gives it a considerable velocity and it is then passed back and forth through a series of blades until the velocity is extracted, the pressure remaining the same. It is then passed through another series of nozzles into a second stage, lowering the pressure and giving it again velocity.

The pressure in the second stage may be atmospheric. In this second stage it is passed through a series of blades to take out the velocity energy and



VALVE LEAD IN A SIMPLE ENGINE

then passes through a third series of nozzles which brings it down to condenser pressure and it is then passed back and forth through other blades and to the condenser. This would be a 3-stage machine. In the largest machines as high as 6 stages are used.

3. In a plain "D" valve the edge of the valve is just at the edge of the port when the piston is at the end of the stroke. The valve then has no lead. If the eccentric be turned forward so that steam is admitted at the outside edge a little before the piston reaches the end of the stroke, the valve will be opened a little when the piston gets to the end of its stroke as shown at A in the figure. The amount that the valve is thus opened is called the lead. This may be steam or outside lead, which would be the amount that the steam port is opened when the piston reaches the end of the stroke, or it may be exhaust or inside lead, the amount that the exhaust port is opened when the piston reaches the end of the stroke.

4. The general rule governing the position of the fusible plug is that it shall be placed so that it will give way when the water level reaches the lowest permissible point. This position differs on different water-tube boilers. In those of construction similar to the Babcock & Wilcox, with horizontal drum, it should be in the upper drum not less than 6 in. above the bottom of the drum over the first pass of the gases.

In the Stirling boiler it should be in the front side of the middle drum, 4 in. above the bottom. In horizontal boilers of the Heine type, in the front course of the drum, not less than 6 in. above the bottom. In Cahall vertical water-tube boilers it should be in the inner sheet of the top drum not less than 6 in. above the upper tube sheet.

Problems for Discussion

What Would You Do Under These Conditions?

UNUSUAL PUMPING STATION ACCIDENT

Tapered Rods Driven Through the Solid Pistons. Where Was There Sufficient Force to Do This?

WHAT proved to be one of the most destructive, and at the same time, puzzling accidents that has come to our notice for some time, recently occured in one of the pumping stations of a large city waterworks.

The damaged piece of machinery was a Holly high-duty horizontal pumping engine. Before describing the accident it may be well to give some details of the construction of the engine to aid in a better understanding of the conditions as they existed before the accident.

Engine is of the beam rotative or crank and flywheel condensing type. It has 2 sets of steam cylinders and pumps connected to one main shaft, with 2 cranks at quarters, and one flywheel common to both.

Each engine has 2 high-pressure steam cylinders, 2 low-pressure steam cylinders, and 2 double-acting plunger pumps. The high-pressure steam cylinders

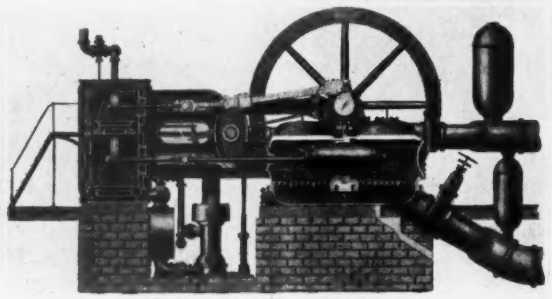


FIG. 1. HOLLY HIGH-DUTY HORIZONTAL COMPOUND PUMPING ENGINE.

are mounted upon and parallel with the low-pressure cylinders. The areas of the latter are usually about 4 times the areas of the former. The steam pistons move in opposite directions and are maintained in their proper relative positions by connection with opposite ends of 2 vertical oscillating beams.

Two pumps are placed parallel to each other, and axially in line with the low-pressure steam cylinders, with which they are directly connected by crossheads. The pump plungers are arranged to work through glands in the center of the pumps. On the top of the pumps, and in line with the high-pressure steam cylinders, are 2 pillow blocks that support the main shaft, flywheel and cranks.

There are 4 heavy cast-iron frames firmly bolted between the inboard ends of the pumps and the steam cylinders so as to hold them rigidly in place, and this combination is further strengthened by heavy cast-iron girders extending from 2 of the frames to the main pillow blocks, these frames containing bearings for the oscillating beam shafts and guides for the crossheads.

Power from the high-pressure steam cylinders is transmitted to the pumps indirectly through the oscillating beams; the power of the low-pressure steam cylinders is transmitted to the pumps directly through the crossheads that connect their piston rods with the rods of the pump plungers. The air pumps are driven from 2 arms that are keyed on the inner ends of the 2 oscillating beam shafts. The steam valves are of the

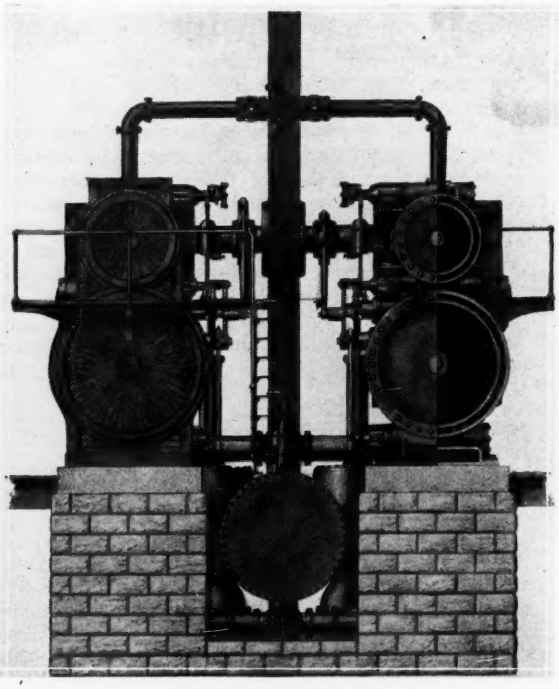


FIG. 2. REAR ELEVATION OF STEAM END OF HOLLY PUMPING ENGINE

Corliss pattern, and are operated from the main shaft by eccentrics connected to wrist plates on the steam cylinders.

Admission valves to the high-pressure steam cylinders open positively at the beginning of every stroke, and close positively so as to cut off the steam at any desired point of the stroke. There are intermediate valves between the high and the low-pressure steam cylinders that serve as exhaust valves to the former, and as admission valves to the latter. These valves remain open for a somewhat shorter period than is required for a complete stroke.

Exhaust valves of the low-pressure steam cylinders operate in the same manner as the intermediate valves.

Suction and discharge pipes lead to and from the outboard end of each pump chamber, and are respectively connected together by easy bends into one common suction pipe and one common discharge pipe.

At the beginning of each stroke, steam is admitted to the high-pressure cylinders under full boiler pressure until the proper point of cutoff is reached, when

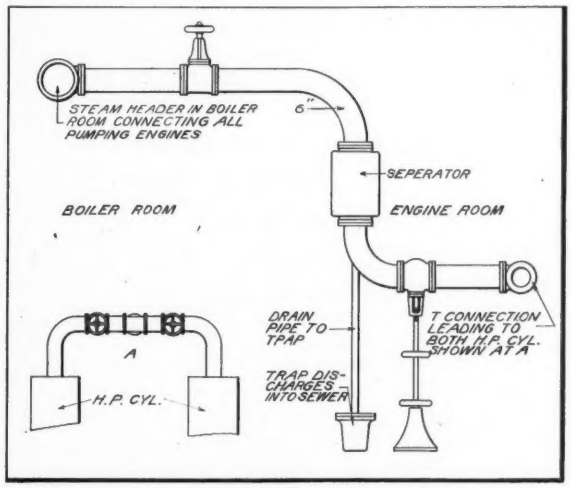


FIG. 3. DETAILS OF STEAM PIPING

the admission valves close instantly, and the expansive force of the steam, with the inertia of the flywheel, carries the pistons on to the end of the stroke. Just before the stroke is completed, however, the intermediate valves open, and the steam not yet fully ex-

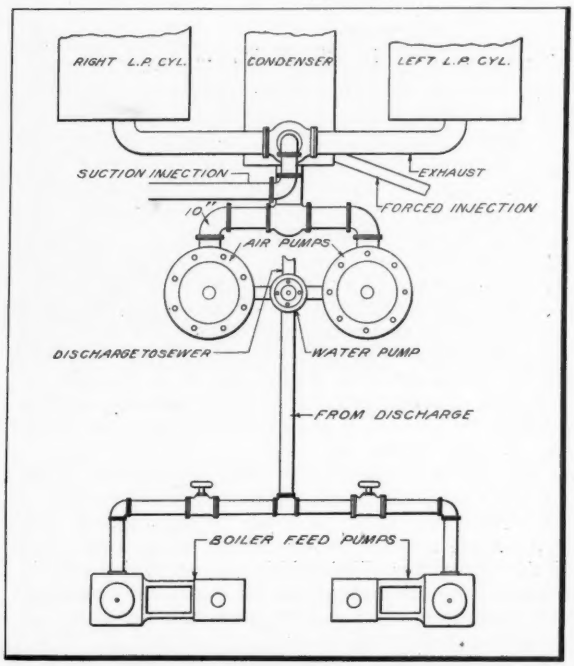


FIG. 4. LAYOUT OF EXHAUST PIPING AND AUXILIARIES

pended passes directly into the low-pressure cylinders, is there again used expansively on the return stroke, and is then exhausted into the condenser. This operation is repeated at every stroke by each high and low-pressure steam cylinder alternately.

The general dimensions of the steam end of the engine are as follows:

Diameter of low-pressure cylinders, 53¾ in.; diameter of low-pressure piston rods, 6 in.; diameter of high-pressure cylinders, 30 in.; diameter of high-pressure piston rods, 4 in.; distance between heads, 44¾ in.; stroke, 42 in.

Figure 1 shows a cross-sectional elevation and Fig. 2 an end elevation of a Holly pumping engine. Fig-

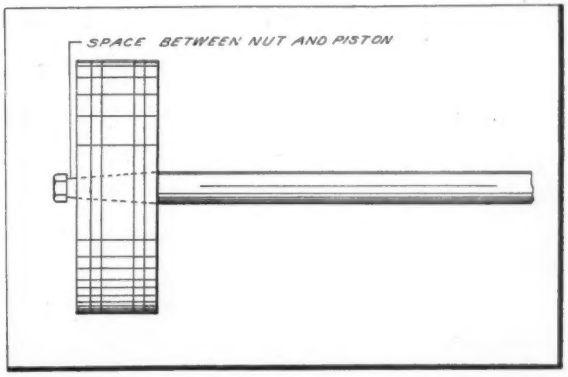


FIG. 5. PISTON SHOWING HOW ROD WAS DRIVEN THROUGH IT

ures 3 and 4 show respectively a sketch of the steam and the exhaust piping.

At the time of the accident the engine had been shut down for about 15 min. and when again started turned over but once or twice accompanied by what was described as a series of loud reports. An inventory of the damaged parts showed that the 4 piston rods, which have tapered ends where inserted in the pistons, were driven through the pistons (Fig. 5) as follows: Right-hand low-pressure, 1⅜ in.; left-hand low-pressure, ⅜ in.; right-hand high-pressure, ¼ in.;

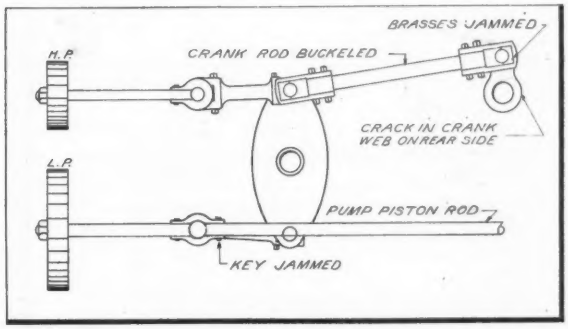


FIG. 6. SKETCH SHOWING RELATIVE POSITIONS OF DAMAGED PARTS

left-hand high-pressure somewhat less than high-pressure on right-hand side.

The right-hand low-pressure piston was stuck about midway in its cylinder, apparently jammed at the sides, so that it had to be drawn out with clamps. By reference to Fig. 6, the remaining injuries, which all occurred on the right-hand side of the engine, will be understood.

The key in the low-pressure cross-head was jammed to such an extent that it had to be drilled out. Just prior to the accident it had been taken up and apparently worked easily in its seat. Further examination showed that the crank rod was buckled outward horizontally and that the crank web was factured

on the inside surface; the crank-pin brasses were also badly jammed.

Upon measuring the cylinders it was found that the greatest wear was parallel with the horizontal axes, making it necessary to bore out about ⅛ in. on the axes of smallest diameter.

The engineers claim that there was no water leaking from the cylinders nor any appearance of water

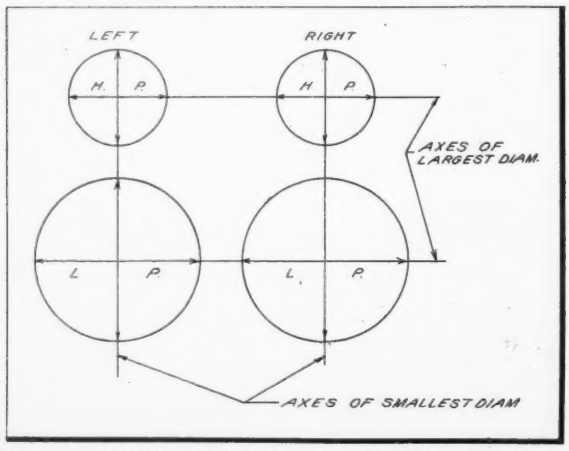


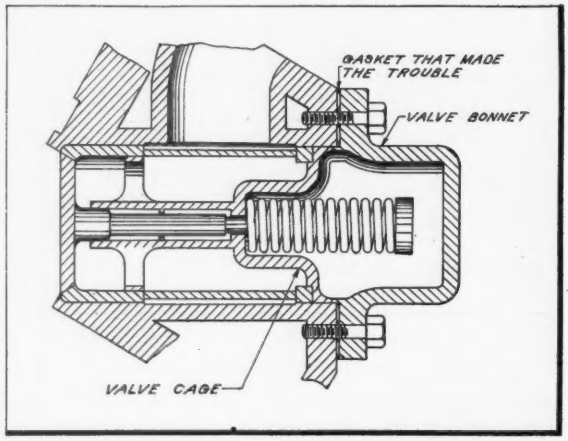
FIG. 7. HOW THE INSIDE OF THE CYLINDERS WERE WORN

on the floor adjacent to the engine after the accident occurred.

The question of what caused the accident is a perplexing as well as an interesting one and suggestions for its solution will be gladly received.

BAD GASKET IN AN AMMONIA COMPRESSOR

IN reading Practical Engineer for November I saw a few letters in the Refrigeration Department. As I am running an ice machine and have been for 14 yr., would like to tell some of my brother engineers of a peculiar happening that occurred to me last July on



BAD GASKET IN AN AMMONIA COMPRESSOR

taking charge of a 20-ton machine. This machine was working badly and going over the entire plant I could see nothing much out of normal, but a good amount of permanent gas in condensers and seemingly dead ammonia. Having a new drum of ammonia on hand I decided to purge the system well by blowing the condensers thoroughly and then disconnecting the pump and line from expansion coils.

Doing so I started to pump air pressure on the tank coils. Opening the air valve on suction arm of the machine I started the engine and then I found the real trouble was in the compressor valves. On taking the bonnets from the suction valves I found the bonnets had been packed with a lead inserted sheet packing which would not stand oil and ammonia and had been eaten away, allowing valve cages to play up and down 3/32 in. and had hammered the sheet of lead which was inserted in the rubber till it was all gone, leaving the valve and cage free in receptacle on head of cylinder. Packing with a good gum packing, allowing the packing to extend out far enough to cover the edge of the valve cages, fixed my trouble and I am making full capacity of the plant. Albert Hickman.

WHEN THE PUMP GAVE WAY

I HAVE been a reader of Practical Engineer for some time and expect to continue as its efficiency is getting better all the time. In the record of emergencies commented on in the November issue, I think something is started which all engineers will find of benefit if each man will contribute his share.

I am employed as night engineer in a sugar refinery where quick action in emergency has pulled me out quite often; I am on nights and the chief expects things to be kept running, and as there is no machinist on my shift I have to repair to keep things moving until the day shift comes on. There are some 35 pumps of dif-

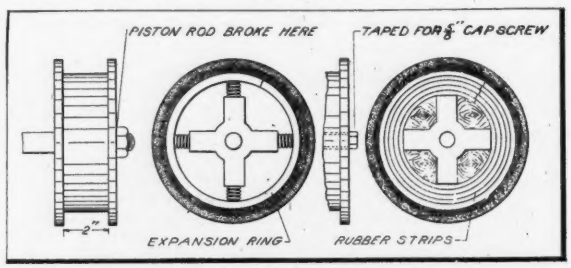


FIG. 1. DETAILS OF THE PISTON AS ORIGINALLY MADE AND WITH EMERGENCY REPAIRS

ferent varieties and trouble often appears. Sometime ago a pump having a liquor end 10 by 14 in., with a pressure or head of 30 ft., refused to do its work and when taken apart was found to have broken the piston rod off flush with the follower plate in the liquor end; her expansion rings were all broken, also the expansion springs.

The first thing I heard from the night foreman was, "Well, how are you going to repair her to keep her running until we can get another rod turned?"

I found that we had in stock, new springs and new expansion rings, and after a few minutes of thought hit upon a plan of action as follows: I had the rod removed and drilled the broken off end to a depth of 2½ in., then tapped it for a ⅝-in. cap screw to hold the follower plate on. Then I filled in the piston between the ribs where the springs had been located with wood, leaving about 2 in. width, and also 2 in. for packing. I then filled the space with old rubber belting cut in 2-in. strips until the space was filled within ¾-in. of the outside then assembled the pump, put in my ¾-in. packing, put the follower plate on and set it up with the ⅝-in. cap screw and started her up.

She did the work as good as ever and when they had a new rod, springs and expansion rings made, about 12 hr. later they found when they took her apart that she was in good condition and still doing good work. This emergency repair took me about 45 min., only holding the house up a few minutes as we had some little reserve in our tank. Roy Stahl.

NEW WATER POWER DEVELOPMENT

ON the Androscoggin River, near Brunswick, Me., a hydraulic development has recently been completed for the Cabot Manufacturing Co., which leased the properties for a number of years to the Pejepscott Paper Mill. This plant was designed primarily to utilize the waste flow during the night and in high water season from a mill already using part of the water power at the same point. The old plant, located on the west bank of the river, uses a timber dam closing off the flow between the 2 high rock abutments that here border the stream, and the new development has provided a passage for the water behind the rock abutment on the east bank.

The river bed is of solid granite, and in the construction of this work it was necessary to erect 2 cofferdams at different levels, enclosing about 106,000 sq. ft. About 4223 yards of rock were excavated and the Aberthaw Construction Company planned the work in such a manner that the stone as blasted was crushed and used in the concrete work, thereby eliminating the necessity of bringing stone from another source.

The dam of the sectional ogee type extends from a ledge in the river to an abutment on the river side of the mill and is constructed of concrete of proportion 1:1½:5, with 30 per cent of the excavated rock embedded, and is 135 ft. long, 27 ft. wide at the base and 7 ft. 5.5 in. wide at the top, which is 20 ft. above the tail water elevation.

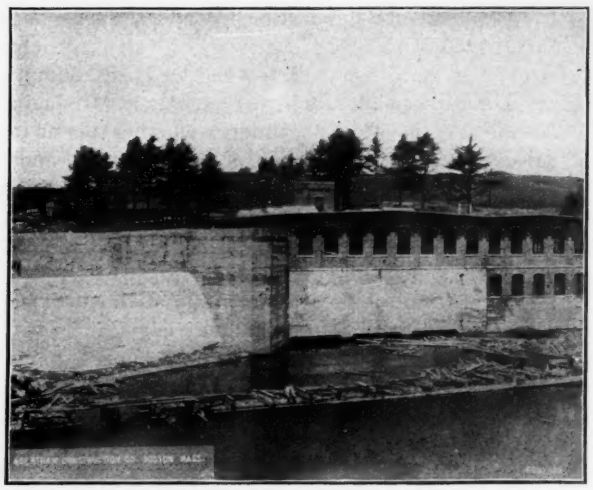


FIG. 1. NEW WATER POWER PLANT OF THE PEJEPSCOTT PAPER MILL

The upstream face is vertical, the downstream face forms an angle of about 32 deg. with the perpendicular and with an 8-ft. arc is swung into the horizontal upper edge of the toe, which, like the upstream face, is keyed into the solid rock. As the slope of the ledge is generally about 30 deg. the height of the dam increases as it approaches abutment, the top of which is 12 ft. above the crest of the dam and about 51 ft. from the bottom of the river on the tail race side of the mill.

The mill itself is a building 116.5 ft. by 112 ft. 8 in. and, with the exception of the one-story brick superstructure, is entirely of reinforced concrete of proportions generally 1:2:4. The head gate platform in front of the mill is 32 ft. by 113 ft. with the gates ahead of the racks, which are protected by a concrete fender wall 23 ft. deep. There are 5 flumes in all. Four of these have 2 gates each with openings 8.5 by 14.5 ft. and are 59 ft. long by 20 ft. wide and 15 ft. deep. The fifth flume is 127 ft. long of the same section, but has 3 gates. Each forebay is about 19 ft. wide and 32 ft. deep.

Each of the 4 smaller flumes contains 3 pairs of 35-in. Victor turbines developing 1370 hp. per unit under a 20-ft. head. These drive only the grinders, 3 to a unit. A pair of 35-in. wheels is located in the long fifth flume, which is used for power purposes. The waste spaces at the ends of the flumes are utilized for white water tanks. Running at right angles to the flume walls are 3 tail races 88 ft. long with a section 18 by 20 ft.

FIG. 2. SCENE DURING CONSTRUCTION OF DAM ON ANDROSCOGGIN RIVER

As to the equipment it may be said that at the present time it is planned to install 12 grinders and 7 wet machines. Over the flumes and back of the forebay is located the wet machine room 68 ft. 4 in. by 110 ft. with a roof of yellow pine plank covered with tar and gravel and supported at the middle by 4 10-in. square pine posts running lengthwise with wooden trusses on either side. On the same level and situated over the long flume is the wood room, 44.5 by 21 ft. Directly in front of the flumes and 14 ft. below the floor of the wet room is the grinder room 44 ft. 6 in. by 87 ft., with a stock chest 10 ft. deep underneath. In this room steel trusses support the roof 31 ft. above the floor. The windows in the mill are abundant, while skylights have also been provided.

This work was designed by I. W. Jones, engineer, of Milton, N. H., and the inspector was Freeman R. Preble. With the exception of the superstructure of brick erected by Charles E. Hacher of Brunswick, the entire contract was executed by the Aberthaw Construction Co. of Boston, Mass.

TO BE POOR in a wealthy country, to be sick in a good climate, to be inefficient among a progressive people, is a sign of unwise educational methods. Such people were not taught to battle with the world or meet life's emergencies.—Thoreau.

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EXTENDING INDICATOR USEFULNESS

In the past the indicator has been used mainly for checking the setting of valves and determining the power developed in an engine. Occasionally, a steam-chest or exhaust pipe diagram has been taken, but adaptations of the indicator for checking up drop in pressure in pipes, correctness of gages, fluctuations of steam flow, etc., has not been general.

When properly cared for, the indicator is less likely to inaccuracy than almost any other testing instrument, hence may well be used as a standard.

Such uses as the above mentioned are largely, however, in the line of checking for leaks and losses. In making tests, because of the uncertainty as to cylinder condensation and leakage, it has been necessary to meter or weigh the boiler feed, or to weigh the outflow from a surface condenser in order to determine the steam composition. The special provision of rather cumbersome apparatus, and the labor involved in taking readings has acted as a hindrance to frequent testing or even to any testing.

Now comes promise of a method by which not only the power developed, but the steam used, the clearance in the cylinder, leakage into or out of the cylinder may be determined accurately from the indicator diagram alone.

Wider use of the indicator becomes at once evident. Instead of a monthly checking of valve setting, a weekly or daily test will tell the steam consumption per horsepower-hour, whether clearance is equalized on the 2 ends of the cylinder, whether piston and valves are tight, correctness of valve setting; and by some measurements and a single series of special tests, the boiler operation and flow of steam can be calculated.

All this means that the indicator will become a means of keeping close and continuous track of plant performance, with a minimum of labor and no disturbance of operating conditions or connection. The indicator will be as necessary to proper operation of of the plant as the coal scoop.

Credit for this remarkable advance is due to the Experiment Station of the University of Illinois, and the complete details will soon be available in the papers of the American Society of Mechanical Engineers and the Bulletins of the Experiment Station, and should be mastered by every engineer who cares to know what his plant is doing.

ACCORDING TO ICE, it is the practice when charging an absorption plant for the first time to use the standard 26 degree (Baume) ammonia liquor, which is supplied especially for this type of apparatus. Under some conditions it might be advisable to use a stronger liquor or a weaker solution. If a weaker solution than this standard is desired, it is the practice to introduce sufficient water to obtain the proper strength. If a stronger solution is desired, it is the practice to introduce pure anhydrous ammonia in sufficient quantity to obtain the desired strength. There is no reason for drawing off any of the weak liquor for any purpose, unless there is too much in the system.

ECONOMICAL LUBRICATION*

Selection, Tests, Use and Record of Oils

By William M. Davis

LUBRICANTS can be divided into 3 general kinds or classes—fluid, plastic and solid. To the first named class belong the various oils, to the second the greases and to the third such substances as graphite, talc or soapstone, mica, etc.

Where the speed is high and the pressure great, oils are satisfactory lubricants to use. They cling to the contact surfaces, forming an elastic coating to the metal, keeping them apart, absorb the frictional heat and carry it away. They can be had in almost any desired grade or density, from the thin spindle oils to the heavy dense cylinder stocks, and they do not become rancid or gummy and contain no free acid.

Greases may be divided into 2 classes, the lime and potash soaps or high melting point greases and the tallow base or low melting point greases.

The first are made by combining a small amount of fatty oil into a soap by means of lime water, caustic potash or other alkali, and mixing it with a large amount of petroleum oil, such as engine oil. Such greases may be made in any degree of density and will have a melting point of 140 to 180 deg. F.

The tallow base greases are composed of a large per cent of tallow combined with an alkali and brought to the desired density by means of vaseline petrolatum or petroleum oils. Such greases, owing to their large content of tallow, are of low melting point, usually about 116 to 120 deg. F.

The high melting point greases usually require to be forced down between the journal surfaces by means of compression grease cups. The low melting point greases can often be packed in the journal box or directly on the bearing. and a low frictional heat will cause them to melt and change to an oil and lubricate the bearings.

All the above is preliminary to a discussion of the subject of Economical Lubrication.

Until recent years, this subject has been given but little thought and attention by those in charge of the operation of machinery, the prevailing idea being that as the cost of lubricants was a small matter, as compared with that of other items, such as fuel, labor, etc., "oil was cheaper than babbitt," therefore use plenty of it. But in these days of keen competition and close attention to operating costs it has been found that it is possible to lubricate machinery efficiently and, at the same time, economically.

Three Essentials to Economy

THERE are 3 essentials to be looked after in obtaining economical lubricating costs: First, to select such lubricants as will give good service as regards cool bearings, low friction loss, etc. Second, to obtain such lubricants at the lowest market price. Third, to see that they are used economically.

Selection of proper lubricants depends upon the class of machinery on which they are to be used. For light running and high speed machinery, the light bodied or more fluid oils will give best results; for slow speed machinery, the heavier bodied oils will be better. For use on slow speed engines where the oil is fed from cups a heavy bodied oil should be used; for high speed work and engines where continuous oiling systems are in use, a light bodied oil should be used.

Cylinder oils have for their base what is known, in the oil trade, as cylinder stock, of which there are 2 classes, the light colored or filtered stock and the dark or steam refined stock, the latter being almost universally used. This cylinder stock is high in flash test and viscosity, but of itself would not make a good steam cylinder lubricant; being a petroleum product, it has no affinity for moisture and will not stick to the wet cylinder and valve surfaces, so it is customary to compound this petroleum stock with a certain amount of fatty oil, usually tallow or neatsfoot oil in order that it will emulsify with the steam and cling to the surfaces.

Where the steam is fairly dry, 3 to 6 per cent is usually sufficient. Where the plant is small and the lubricating cost is a small matter, the most satisfactory method of purchasing lubricants would be to buy of some reliable oil firm, but where the cost of lubrication runs into thousands of dollars, as is the case with many corporations, and it is desired to obtain suitable lubricants at the lowest market price, the best plan is to purchase on specifications, stating clearly just what is needed and awarding a contract for a year's supply to the lowest responsible bidder. Specification buying is fair to both the consumer and the dealer.

Specifications are simply knowing what you want, and stating it on paper.

Testing

THE usual physical tests for gravity, flash test, cold test and viscosity, and in the case of cylinder oils, a chemical analysis for percentage of fatty oil, which are very easily made, will give anyone who is familiar with lubricants a close indication of the relative values of different oils. If one wishes to go further it is often possible to make actual service tests which will show absolutely any difference in the lubricating property of 2 or more oils.

The mechanical world owes much to the careful experiments into the theory of friction by such able men as General Morin, the late Dr. Robert H. Thurston, and especially so to those of the Secretary of this Association, Dr. Woodbury, and the information derived from such experiments has been of great value to engineers.

Bearing Test

MACHINES on which their tests were made however are not always available, but if it is desired to make a series of service tests, take a bearing that is running under constant load and speed, such as the main bearing of a high speed engine. Place a thermometer in the bearing so that the bulb rests on the shaft, and maintain a constant feed of oil. Have another thermometer placed somewhere in the room near the bearing and out of drafts, so as to show the temperature of the room.

Commence the test when the engine is started, note the rise of temperature at frequent intervals;

*Abstract of a paper before the National Association of Cotton Manufacturers.

also that of the room, continuing the test until the temperature of the bearing ceases to rise. Every bearing will in the course of a few hours reach a point where the heat is radiated as fast as it is generated. Deducting the temperature of the room from that of the bearing will give the temperature due to friction.

If the engine runs in the daytime only, the bearing will cool off during the night, then the next day repeat the test with another oil. This data may be plotted on diagram paper so as to show in a graphical manner the different rises in temperature with various lubricants.

While it is no doubt true that in experimental work it has been found that the coefficient of friction often decreases with rise of temperature, yet in everyday practice it is safe to assume that of 2 oils the one that will keep the bearing the cooler, is the better lubricant, so in tests of this kind the oil showing the least rise of temperature will be the best lubricant. Such tests can often be made in ring oiled bearings of motors, dynamos or shafting.

When making such tests it would be well, after finishing one test and before commencing another, to wash out the bearing with gasoline.

Cylinder Test

IF it is desired to ascertain the lubricating value of 2 or more cylinder oils, take one oil and feed it at a given rate for a few days, then remove the cylinder head and wipe over the surface with a piece of soft white paper. If a good stain of oil is found it is evidence of good lubrication. If there is no stain of oil and a liberal amount has been used, it indicates either that the steam is very wet, or that not enough fatty oil has been used in compounding the lubricant.

This same test can be used to determine the least amount necessary to maintain good lubrication. By gradually reducing the oil feed and examining the surfaces from time to time the proper amount necessary to maintain good lubrication can be determined. Of course, where tests of this kind are to be made some means must be provided for easy removal of the cylinder heads.

Feeding Oil

NEXT to the question of buying, efficient and economical lubrication hinges on the methods of handling and applying the lubricant. Reliable appliances for feeding lubricants will save money. There are many ways by which every manufacturer can decrease his oil bill, notably by right methods of handling and using the lubricants. In many cases, too, by substituting one lubricant for another and perhaps cheaper variety which will do the work just as effectively, a great reduction in cost can be made. For instance, I have found many cases where a high priced cylinder oil was used to lubricate general mill shafting and machinery where an ordinary machine oil or cylinder stock would have answered just as well and at half the cost.

It is simply a waste of money to fit engines with a continuous oiling system unless all necessary precautions are taken to recover the oil used.

On the other hand it is surprising how little new oil is really needed to make up the loss. As an instance, at a certain plant in one of the suburbs of Boston, there are 2 vertical compound engines of several hundred horsepower each, running at 125 r.p.m. about 11 hr. a day. The oil flows in streams over the bearings yet so well protected are they that a barrel or 50 gal. of oil lasts 6 months.

Actual Savings

AT another plant there are 2 single cylinder horizontal engines, about 24 by 48 in., running at 100 r.p.m. Before being equipped with an oiling system these engines used about 200 gal. of oil a month at a cost of $50. After being equipped and means provided to prevent loss by leakage, etc., the monthly consumption was reduced to less than 10 gal. At the same time a change was made in the kind of oil used, which cost considerably less money, with the result that these same 2 engines are running right along month after month on a cost for engine oil of less than $1.50 per month.

A rather mysterious loss of engine oil was traced to a peculiar cause. While making an inspection of the plant of a client in Illinois, I found by the records that from 300 to 400 gal. of engine oil were required a month to make up the loss on 2 compound engines. The engines were fitted with a continuous oiling system with excellent facilities for preventing loss. The cranks, eccentrics and crossheads being cased in to prevent the oil being thrown out.

Oil was used freely on the crosshead pins and guides. Under the piston rod stuffing boxes and between the cylinder heads and the end of the bottom guide there was quite a large cavity or depression in the casting. From the bottom of this was a drip pipe but the engineer kept it closed, allowing the cavity to fill with oil so that when the crosshead went out oil flowed along the bottom guide. The crosshead shoe on the return stroke splashed the oil up against the hot cylinder head. As they were using steam in the high pressure cylinders at 150 lb. per square inch there was sufficient heat to burn the oil which was indicated by the cloud of smoke continually coming out of the crosshead barrel. At my suggestion the engineer allowed this oil to drain into a tank with the result that this cause of loss was stopped.

Besides what was lost from this cause it was found that the oil soaked waste used in wiping up was sent to the boiler room to be burnt. The installation of an oil and waste saving machine stopped this loss.

Oil Lost in Waste

ANOTHER cause for loss often occurs in wiping up with waste. The oily waste then goes to the boiler room to be burned. In wiping up around engines it has been found by experiment that a pound of dry waste will, after being used and squeezed out by hand, weigh 2 lb., or, as the writer found at one plant, there was a loss of one gallon of oil for every 10 lb. of dry waste used; this in itself is quite an item. In most large plants it will pay to install some make of oil and waste saving machine, by means of which the oil is extracted and filtered and the waste washed, dried and used over again.

To give an idea of what this loss sometimes amounts to, the writer, while inspecting lubricating conditions at the mill of a client, found, on inquiry, that they were using waste at the rate of 28,000 lb. a year. Most of this waste was used for wiping up around the engines and machinery on which a great deal of oil was used. All of it was sent to the boiler room to be burned. As the waste was heavy with oil, it is safe to say that at the very least, 2000 gal. of oil together with the waste, were lost per annum.

Oil Storage

RECEIVING, storing and distributing lubricants, are other important factors in economical lubrication. If the plant is a large one where several thousand gallons of oil are used a year, it will pay to provide storage capacity so that the oils can be bought in tank car lots. In this way there will be a reduction in the price and also a saving in the amount of labor required to handle the oil.

But if it be a small plant where only a few barrels of each kind of oil are used a month, the oil should be kept in tanks so arranged that the barrels can be emptied into them by gravity. Care should be taken to see that the barrels drain out thoroughly. As the empty barrels are worth 75 cents to a dollar or more each, they are worth saving and should be kept in a cool place to prevent shrinking until enough have accumulated to make a carload. When sold, the amount received should be credited to the lubricant account.

It is customary in a large plant to have some one in charge of the oil house, to receive and store the lubricants, and issue or deliver them to the various engine rooms and departments, keeping a record of the amounts issued in a book or on a blank form provided for this purpose. This is quite as important in a small plant and can be done without great effort or expense.

In one plant the various departments are provided with cans or small tanks of size sufficient to hold a few days' supply. The name of the rooms or departments to which the cans belong are stamped on strips of sheet brass soldered upon the cans. Leaky cans or cans with broken spouts tend to wastefulness, the repair man should periodically gather up all such cans and repair damages or fit new spouts before returning the cans.

No oil should be issued except on a requisition signed by the chief engineer, master mechanic or department foreman. In one small plant where the amount used does not warrant keeping a man especially to look after the lubricants, the oil house is placed in charge of the general storekeeper and opened only at certain times, half an hour or so in the morning and the same time in the afternoon. The men come or send for their supply of oil at these times. At all other times the oil house is kept locked.

Cost Record

AT the end of the month the amounts of lubricants issued should be totalized and entered on a blank. The totals when multiplied by their price per gallon or pound will show the cost of each kind of lubricant used and also the amount used in each engine room and department and its cost. By comparing reports month by month it can be seen whether the cost is increasing or decreasing and in what departments the differences have taken place.

By dividing the total cost by some unit of product or output, such as tons, pounds, yards, kilowatt-hours or whatever it may be, the cost of output can be determined and entered on the report sheet. There should also be a place to enter the amounts of oil purchased during the month, the number of empty barrels sold and the amount received for them. Thus a complete record of the lubricant cost can be kept on one sheet.

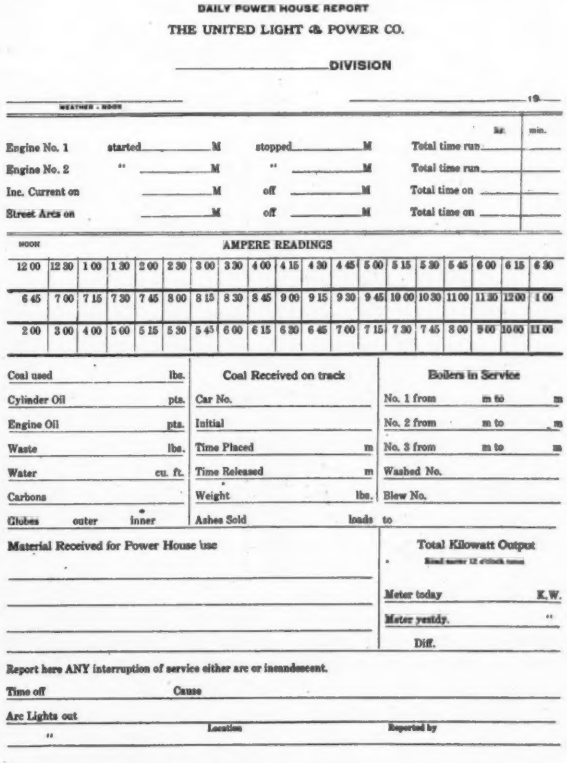
Considerable saving can often be effected by reducing to as few as possible the number of different kinds of lubricants. Many persons in charge of machinery have an idea that they must have some certain brand of oil, and that they will have all kinds of trouble if they should attempt to use anything else. In a factory the writer found that in one department the foreman insisted on having a special brand of oil, the price of which was such that it was costing $1.17 per machine per month. (There were more than 100 machines in operation in his department.) At all the other plants belonging to the same company this same make of machine was costing less than half that amount per machine per month for lubrication.

At the mills of a certain company where the writer had been engaged to reorganize the lubricating practice, it was found that 9 different brands of cylinder oil, 5 brands of machine oil and a dozen or more different kinds or grades of greases were in use. Some were fairly reasonable in price, others inordinately high. Four brands had a different price, yet analyses and practical tests showed that they were all of good quality, but no one better than another.

A few plain common sense tests and demonstrations soon showed the fallacy of all this, and after that one grade of cylinder oil and 2 grades of engine and machine oil answered every need. As to grease, it was soon shown that 3 kinds or grades would answer every requirement.

DAILY RECORD

HEREWITH is a suggestion for a daily power house report, reduced to half the original size, which gives, for a moderate sized plant, most of the data needed for computing fuel, water and supplies consumption, and, with prices and labor costs known, the cost per pound of steam and per kilowatt-hour.



DAILY POWER HOUSE REPORT

THE UNITED LIGHT & POWER CO.

_____ DIVISION

_____ 19__

WEATHER - MOON

						hr.	min.
Engine No. 1	started	M	stopped	M	Total time run		
Engine No. 2	"	M	"	M	Total time run		
Inc. Current on		M	off	M	Total time on		
Street Arcs on		M	off	M	Total time on		

MOON — AMPERE READINGS

12 00	12 30	1 00	1 30	2 00	2 30	3 00	3 30	4 00	4 15	4 30	4 45	5 00	5 15	5 30	5 45	6 00	6 15	6 30				
6 45	7 00	7 15	7 30	7 45	8 00	8 15	8 30	8 45	9 00	9 15	9 30	9 45	10 00	10 30	11 00	11 30	12 00	1 00				
2 00	3 00	4 00	5 00	5 15	5 30	5 45	6 00	6 15	6 30	6 45	7 00	7 15	7 30	7 45	8 00	9 00	10 00	11 00				

Coal used	lbs.	Coal Received on track	Boilers in Service
Cylinder Oil	pts.	Car No.	No. 1 from m to m
Engine Oil	pts.	Initial	No. 2 from m to m
Waste	lbs.	Time Placed m	No. 3 from m to m
Water	cu. ft.	Time Released m	Washed No.
Carbons		Weight lbs.	Blew No.
Globes outer	inner	Ashes Sold loads to	

Material Received for Power House use

Total Kilowatt Output

Read meter 12 o'clock noon

Meter today K.W.

Meter yestdy. "

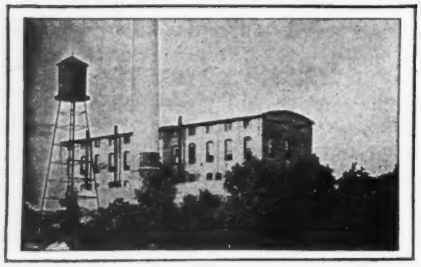
Diff.

Report here ANY interruption of service either arc or incandescent.

Time off Cause

Arc Lights out

" Location Reported by



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

SAVING EXHAUST HEAT

Boiler for Heat Recovery From Gas Engine Exhaust Saves 30 per cent of Heat Furnished to Engine and Silences Exhaust

By John L. Bogert

THE New York Engine Co., of New York City and Watertown, N. Y., has installed in the power house of its boiler shop within the past 6 mo. an interesting example of combined exhaust silencer and water heater. It has been long recognized by gas engine designers that the temperature of the escaping exhaust gases is sufficiently high to be used for the purpose of heating and in England, a considerable business is done at the present time, with a horizontal type of tubular boiler through whose tubes the exhaust gases pass on their way to the atmosphere.

Manufacturers of that boiler claim the ability to generate from 2½ to 3 lb. of steam at 60 lb. pressure per brake horsepower hour, when the engines are operating at nearly their rated capacity. The great disadvantage of the Wilson boiler has always been the amount of room needed for installation, and likewise, the fact that being made wholly of steel plate and boiler tubes, the boiler suffers a rapid deterioration when coal of a sulphurous nature is used. To meet these objections some 2 yr. ago there was designed a cast-iron sectional boiler, which combines well distributed heating surfaces, with gas passages of efficient shape for reducing the velocity of the escaping exhaust and thereby insuring silent flow

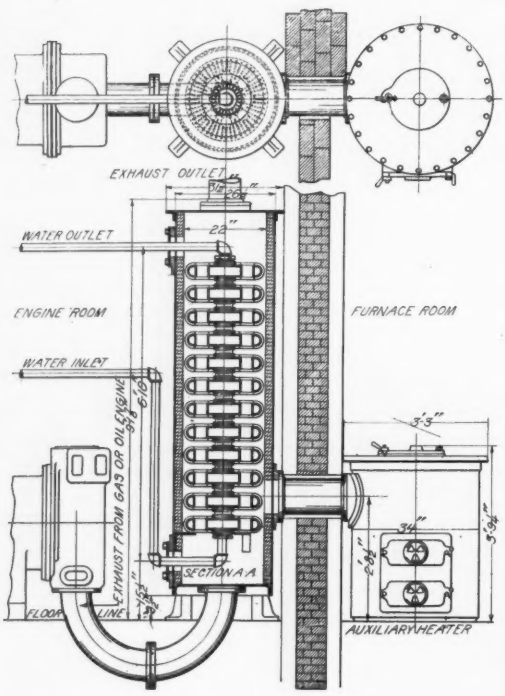


FIG. 1. VERTICAL SECTION OF BOGERT EXHAUST HEAT RECOVERY BOILER WITH AUXILIARY FURNACE FOR HEATING WHEN ENGINE IS SHUT DOWN

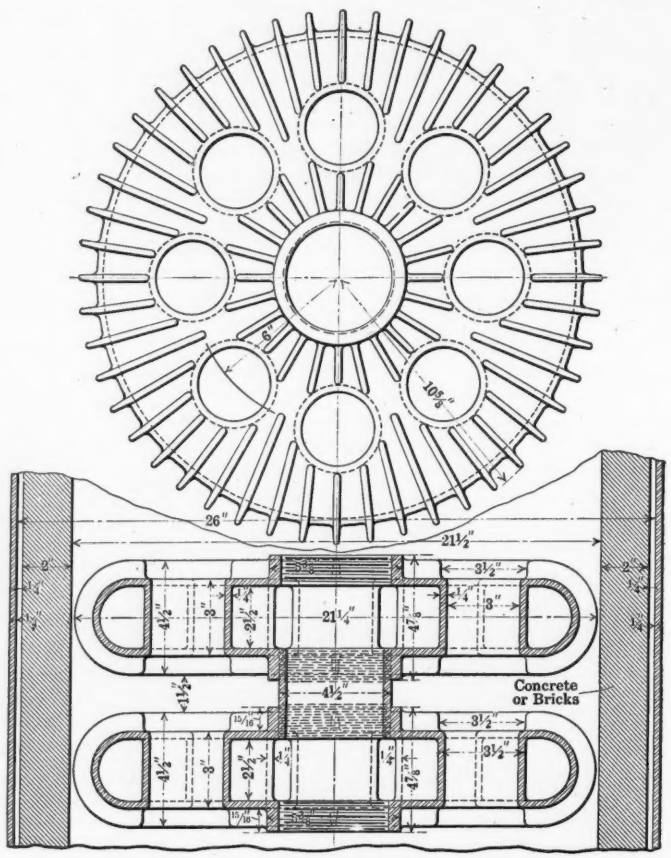


FIG. 2. PLAN AND SECTION OF INDIVIDUAL SECTIONS OF BOGERT BOILER

to atmosphere. Being a sectional boiler, any section can be easily placed.

Figure 1 shows a vertical section of one of these boilers, having 12 sections, and Fig. 2 shows a plan, and a section on a larger scale of one of these sections, from which the method of building up the boiler can be readily understood. The outside shell is of steel plate, but it is lined with concrete or ordinary brick standing on end for the purpose of confining the heat and also preserving the shell from oxidation.

It is a well recognized fact that the way to reduce the noise of the exhaust of the gas engine is to provide numerous short passages connecting expanding chambers so that the velocity of the gas may be gradually reduced without any serious back pressure being developed. The small space taken up by this apparatus can well be seen in inspecting Fig. 3, which is a view of a power installation of 2 50-bhp., suction producer gas engines, discharging their exhaust through one Bogert heater. The jacket

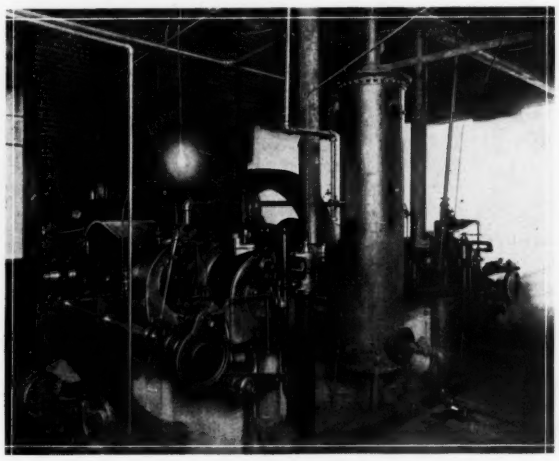


FIG. 3. INSTALLATION OF HEAT RECOVERY BOILER WITH 100-HP. TWIN ENGINE

water is fed from the jacket of the engine into the heater ,and passes out to the system, where it is to be used.

The twin engines shown in Fig. 3 of 100 bhp. at 200 r.p.m. with an overload capacity of 15-20 per cent. The space occupied is 13 by 11½ ft., and it will be noted that the exhaust heat boiler is also the silencer and occupies a position midway between the 2 cylinders. These latter are 15 in. diameter by 21 in. stroke, and the cranks are set in line so that the power impulses are 360 deg. apart. Jacket water enters at the explosion end and passes out to the exhaust heater from the inner or crank shaft end of the cylinder barrel, its temperature being raised from 65 to 130 deg. F. in passing through the jacket. After it has passed through the exhaust heater its temperature will have been raised to 212 deg. F.

As 3000 B.t.u. are recovered in the shape of hot water per brake horsepower-hour when the engines are run with a load factor of 75 per cent, it is easy to see what a considerable amount of heat can be saved that otherwise would be wasted. The cut shows clearly the small amount of room taken up by this device. The main driving belt is 24 in. wide and transmits the power of the engines to the main line of shafting in the boiler shop through a friction clutch. The boiler shop building is 225 by 63 ft., and contains the usual machinery equipment required for that class of work.

There are 3 principal lines of shafting—the main line, 200 ft. long, running close to the engine room, the middle line, 60 ft. long, which drives 50 ft. of shafting in the sheet metal shop, and a third line, 110 ft. long, running on the opposite side of the boiler shop.

These several lines of shafting drive 16 machines consisting of bending rolls, sheet planers, shears, pipe threading machines, grinders, blowers, drills, etc. Besides driving this boiler shop outfit of machinery, these same engines drive a 2-stage compressor that furnishes compressed air to the whole plant. This latter machine is belt driven off the main line of shafting and has cylinders 9 and 15 by 12 in. and is rated as requiring 70 hp. When the engines are driving the 420 ft. of shafting together with the various machine tools belted therefrom, besides the air compressor, they are fairly well loaded.

The fuel consumption varies from 50 to 70 lb. of pea coal an hour, and the fire has not been allowed to go out in over 3 mo. The fact that including all standby losses these gas engines run 10 hr. a day on 700 lb. of fuel, or less, shows what a desirable type of prime mover they are.

Two different systems of water circulation may be used in the Bogert Exhaust Heat Recovery Boiler—natural and forced. The former, Fig. 1, is automatic; the latter requires mechanical means such as a small rotary pump.

With the latter the water is forced through the exhaust boiler in a direction of flow opposite to that of the hot gases, so that the coldest water is warmed by the coldest gas, and the hottest water by the hottest gas. More heat is recoverable in the latter case than in the former, especially if the temeprature of the water when it leaves the boiler is to exceed 190 deg. F.

At night a coal, gas or oil fire is started in a furnace which discharges its products of combustion inside the shell of the exhaust boiler, thus converting the latter into one of the most efficient hot water heating boilers imaginable. Where the heating of a building is the use that the exhaust heat boiler is put to, the natural system of circulation will be preferable since at night when the engine is not running there will be no power available for forced circulation.

Silencing of the escaping gases is easily accomplished, since their alternate expansion and contraction occurs at the passage through and around each separate section. The strength of these sections is adequate as it required 1200 lb. per sq. in. of hydraulic bursting strain to rupture one at a recent test, and the enclosing steel shell would probably resist a bursting strain of 500 lb. per square inch.

A NEW LINE OF CENTRIFUGAL PUMPS

THE Goulds Manufacturing Company, of Seneca Falls, N. Y., has just placed on the market an entirely new and improved line of centrifugal pumps, furnished in both the single stage, single suction and single stage, double suction types, either of which type may be arranged for belt drive or direct connection to electric motor, gas, gasoline or steam engines, steam or hydraulic turbines. The single suction, as well as the double suction pumps, contain many special features which are very important from an operating and economical standpoint.

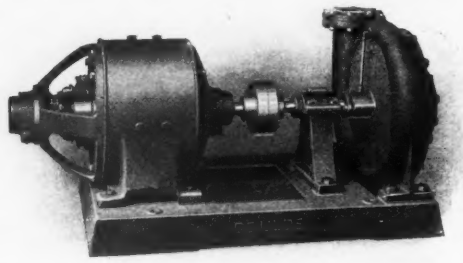
The impeller in the single suction pump is of the open type. The vanes are carefully designed so that the maximum efficiency is obtained under normal conditions. The impeller is accurately machined to min-

imumize the clearances between the impeller and the side covers, a feature having considerable influence upon the high efficiency which is obtained with this type of pump.

Although of the single suction type, which in most cases means a considerable amount of end thrust, the impeller in the Goulds pump is designed in such a manner that this annoying feature is entirely eliminated.

The stuffing box, through which the shaft passes, has a brass water sealing ring preventing air being drawn into the pump at this point. Air will destroy the vacuum in a pump and impair suction.

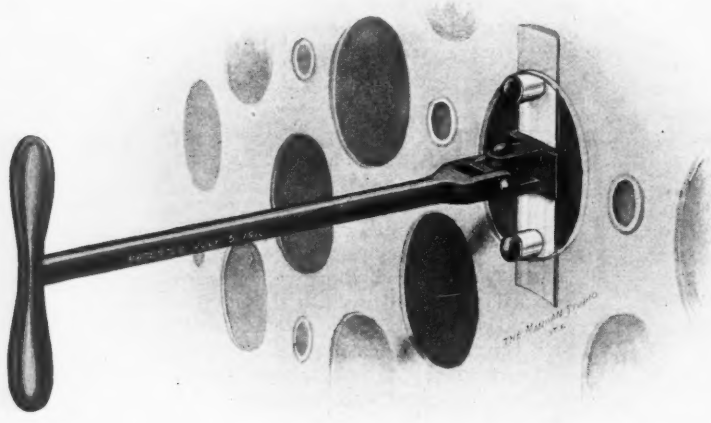
The single stage, double suction centrifugal pumps are designed with a view of combining all mechanical details necessary to produce a centrifugal pump of the highest grade. The casing proper consists of 2 castings bolted together on a horizontal joint. The purpose of dividing the casing is to permit quick and



SINGLE STAGE, SINGLE SUCTION GOULD'S CENTRIFUGAL PUMP, MOTOR DRIVEN

ready access to the interior parts of the pump for inspection, without disturbing the pipe connections. The impeller is of the most modern enclosed type and develops the highest efficiency under the conditions for which the pump is sold.

The bearings are of the ring oiling type, independent of the stuffing boxes, and are provided with removable shells lined with the best quality of antifriction metal.



THE BAYER HAND HOLE SCRAPER IN ACTION

The double suction pumps are made for heads up to 150 ft., while the single suction pumps operate against maximum head of 100 ft.

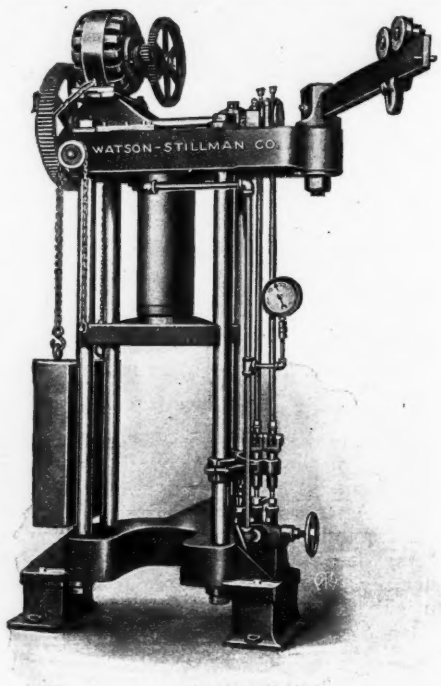
A CONVENIENCE FOR WATER TUBE BOILERS

WHEN replacing the handhole covers of water-tube boiler waterlegs, one of the uncomfortable and inconvenient operations is scraping away the remaining particles of packing and other accumulations from around the handholes on the inside of the sheet. The tool which is here represented, a handhole scraper manufactured by the Bayer Soot Blower Co. of St. Louis has been devised to overcome that difficulty.

The illustration shows the position ready for use. The cutter is a hollow ground, substantial plate, made of highly tempered steel and connected to a malleable iron handle by a swivel joint that the cutter will at all times get perfect bearing on the inner surface of the sheet and also it can be turned down parallel with the handle for insertion or removal from the waterleg. The guide rollers are mounted on posts and serve to keep the scraper in proper position when being used. The blade can be removed for regrinding when needed. The scraper is being sent out by the manufacturer for trial to those who are interested in seeing how it works.

HYDRAULIC PRESS

ILLUSTRATED herewith is a press which was designed for F. F. Gaines, superintendent of motive power of the Central Railroad of Georgia, and has proven successful for pressing journal box bearings into and out of place. The press is also useful for broaching, key-seating, putting gears on srafts, pressing bearings, handling mandrels and general railroad



HYDRAULIC LOCOMOTIVE BOX PRESS

shop work where heavy pieces are to be forced together.

A crane bracket and beam are extended from one

end so that the work may be swung into the press without any hard manual labor. A back-geared motor, mounted upon the pedestal on top of the press, drives the pump shaft. Upon the other end of this shaft are 2 pump eccentrics. The pump pistons are both ¾ in. diameter by 2 in. stroke, and the pedestal legs act as reservoirs for the pump. The operating valve shown is a single screw stem valve which releases the pressure from the work when open and starts the ram down when closed. A safety valve is used in connection with the pump to stop dangerous overload. The press is made in 2 sizes, 60 and 100 tons capacity respectively, and is also furnished hand or belt-driven if desired. This press is built by the Watson-Stillman Co., of 50 Church St., New York.

THE LORD WATER SOFTENER

WATER softening is in the nature of a permanent investment and improvement to any power plant; therefore, investigation of the merits of the various water sofeteners with reference to simplicity, durability and economy is decidedly worth while.

The cuts herewith show views of the Lord Model "A" Automatic Water Softener and Purifier, and the following description tells of its workings.

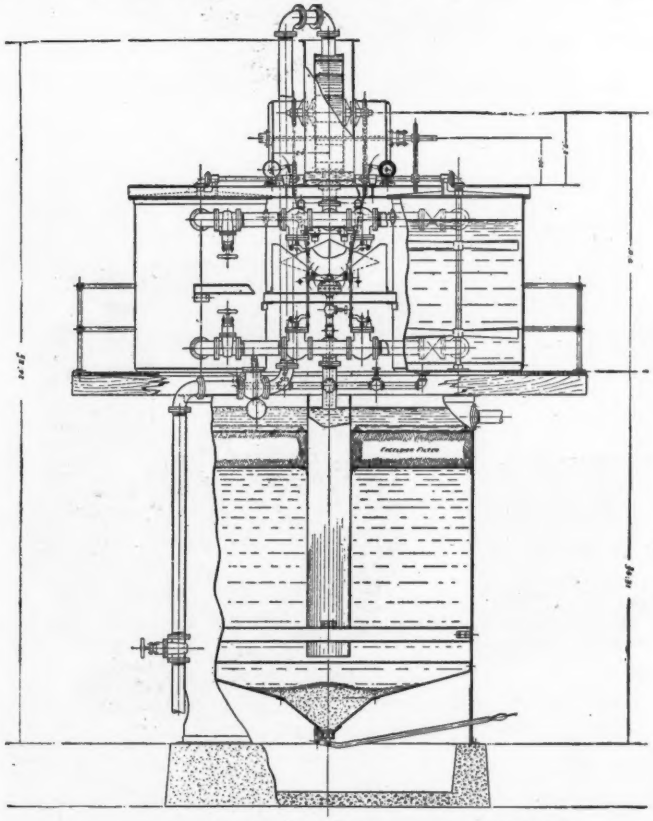


FIG. 1. PLAN AND SECTIONAL SIDE ELEVATION OF LORD WATER SOFTENER

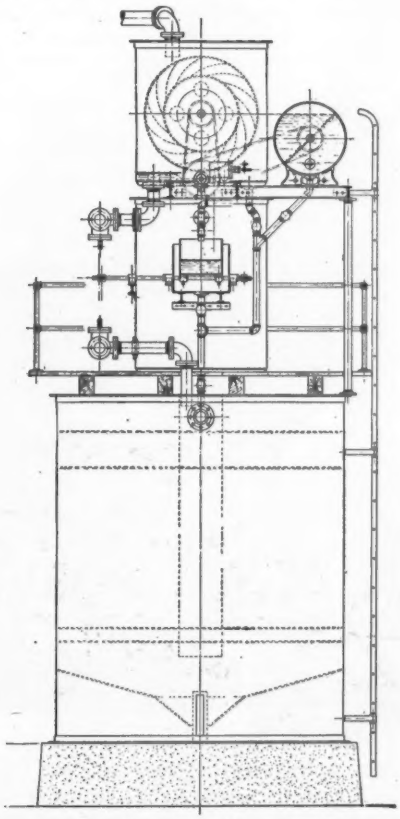


FIG. 2. END ELEVATION OF LORD AUTOMATIC WATER SOFTENER

Water enters through an inlet pipe and passes over a water wheel, which furnishes the power for the operation of the filter. The shaft supporting this wheel is connected by a chain drive with a horziontal shaft above the 2 mixing tanks, which in turn are connected by miter gears with 2 vertical shafts, equipped with paddles for agitating the water in the mixing tanks, thus aiding the precipitation of injurious solids. This water wheel also drives paddles in a chemical storage tank, which continually agitates the solution of chemicals, so as to keep it of uniform consistency and strength at all times.

These purifiers are also equipped with chemical measuring valves which regulate the amount of chemicals used from time to time, and are operated by a dumping bucket. The bucket also opens and closes a series of lever valves at proper intervals, thus giving a complete automatic action.

After the water leaves the wheel, it enters the upper line of pipe, and flows first to the right and then to the left, the flow being regulated by the lever valves referred to above, which are connected with the inflow and the outflow pipes. For example, the water first passes through the pipe leading into the right-hand mixing tank until this tank is completely filled. After this, a sufficient amount of water overflows through a pipe in the upper part of the tank into the dumping bucket, which tilts and closes one upper valve and opens the lower valve directly underneath, thus allowing the water to flow from the mixing tank and enter the main filter tank of the purifier. This action is then repeated in the left-hand tank, and runs indefinitely until the storage tank is filled.

After the agitation is completed, the water flows through a center partition or cylinder into the main filter tank, which separates the raw water from the treated water, and after this flows upward through the filters and overflows into the storage tank at the side, or directly into the boilers.

Precipitates, in the meantime, settle into the funnel shaped base of the filter tank. Some of the precipitates may be carried up a slight distance, but being heavy, the tendency is to settle, and on the downward flow they naturally come in contact with other particles rising, and unite with them, causing them to fall to the base of the purifier, where they are removed through a sludge valve intended to convey the sludge or impurities into the sewer. The filters remove any remaining traces of precipitates, the result being a perfectly pure water, suitable for all manufacturing or industrial purposes.

The chemical measuring valve holds a definite amount of the reagents furnished for precipitating the injurious solids. This valve is equipped with an inner measuring cup and brass sleeve on the outside, over which this cup slides back and forth. The cup itself has an opening at the bottom, and a small opening or air vent at the top, which allows the air to pass in and out at proper intervals. The valve is operated by the dumping bucket as it tilts back and forth, which causes the opening in the inner cup to rotate back and forth, so as to come directly in contact with the 2 ports, on the right and left, one of which is connected with the chemical storage tank and the other with the mixing tank.

This allows the measuring valve to be filled and emptied at regular intervals, making the action entirely automatic. In this way a definite amount of chemical solution is fed into the mixing tank at regular intervals, the amount being properly proportioned.

The float valve connected on the inlet pipe is operated in connection with the storage tank and controls the entire system, inasmuch as the water in this storage tank, as it gradually fills, will close the valve and thus cut off the supply of water. As the water subsides or is drawn from the storage tank, from time to time, the float valve will naturally fall or open, thus allowing the water to pass through the lines and the operation of the plant continue.

The Lord Water Softener is intended for the cold water treatment of feed waters, especially those in use along railroads, and in industrial plants where a large battery of boilers is required or where a water highly charged with injurious solids is being used.

The softener is manufactured by the Geo. W. Lord Co., of Philadelphia, Pa.

A SAFETY VALVE FOR LOW PRESSURE

ATMOSPHERIC relief valves, such as are used to protect exhaust steam heating systems, feed-water heaters and other apparatus against dangerous accumulation of pressure, are in fact safety valves but differ from the high-pressure type in design. The ordinary safety valve discharging at a pressure of 150 lb. has a steam velocity of 2000 to 3000 ft. per second, and the density under these conditions, in the smallest cross section of the orifice corresponds to a pressure about 60 per cent as great as the initial pressures, so that a small opening will discharge a considerable weight of steam.

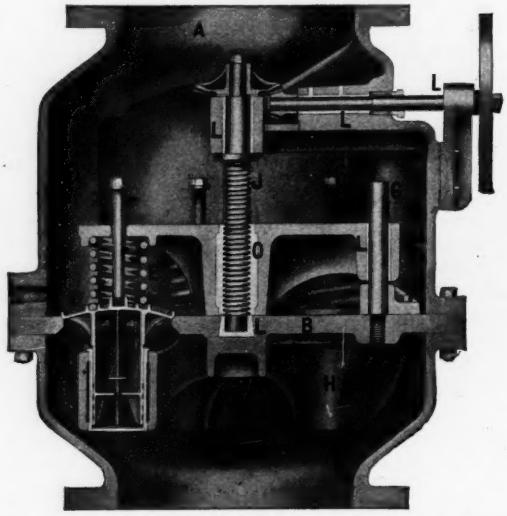


FIG. 1. SECTION OF COCHRANE MULTIPORT SAFETY EXHAUST OUTLET VALVE

FIG. 2. COCHRANE MULTIPORTED VALVE FOR 16-IN. PIPE; PRESSURE PLATE IN HIGHEST POSITION

FIG. 3. PRESSURE PLATE IN LOWEST POSITION

On the other hand, under a back pressure of 6 lb., steam escaping to the atmosphere has a velocity of only 1000 ft. a second or thereabouts so that to discharge the same weight of steam in a given time the area of the valve opening must be about 30 times as great as in the case of the boiler safety valve. It is therefore of little

use to put an ordinary safety valve on a feed-water heater or a cross pipe, because due to the small discharge area such a valve has hardly any perceptible influence on the rise and back pressure, if the flow of exhaust steam to the atmosphere be blocked while the engine is running at full load.

In the design of the Cochrane, multiport safety outlet valve, the 2 principles of a number of small sized openings rather than 1 large opening, and a spring loaded valve have been embodied. It consists of a valve deck upon which are placed a number of small discs, each individual disc having a spring to hold it closed; a water cushion or dash pot to arrest its motion and prevent damage to the disc and its seat; and a stem by means of which it may be lifted free of the seat when desired.

Tension of the springs is determined by the position of a pressure plate which is adjustable by means of a vertical screw. This screw may be turned one way or the other by means of bevel gears connecting with a horizontal shaft which extends to the outside of the valve casing and is fitted with a hand wheel, chain wheel or bevel gear as circumstances may dictate.

As shown in Fig. 1, the valve deck is placed between the flanges of the bottom and the top castings, the top casting having 2 or more hand hole plates or doors to give access to the deck.

Advantages of this type of construction are obvious; each valve has a comparatively small lift in order to give an opening equal to the area of the valve opening; in case one disc should be put out of order, all the other discs will continue in operation and the valve will work nearly as well as when all discs are in proper condition. Individual discs are small and light and as they have only a small lift and are held to their seat by springs instead of weights, the mass in motion is small, and discs even when opening and closing rapidly do not hammer their seats.

To still further reduce the possibility of damage to the seat, cushions of water in the dashpot beneath the discs act to take up the force of the discs in closing.

Pressure plate and hand wheel give a quick and easy means of adjusting the back pressure to whatever may be desired and in case the pressure is not sufficient with the pressure plate clear down, springs can be substituted to give any desired pressure. The improved type of valve illustrated and described is known as the Cochrane Multi-port Safety Exhaust Outlet Valve, and is manufactured by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa.

OUTDOOR TYPE OIL CIRCUIT BREAKERS

COMPANIES distributing electric energy over long transmission lines are often anxious to take on business along these routes, but the volume is usually so small that the consequent revenue does not begin to justify the erection of a substation with its attendant expense. Outdoor type apparatus has gone a great way towards solving the problem. The most important piece to be considered in such an installation being the oil switch or circuit breaker for the control of the feeder circuits.

Another advantageous use of outdoor type oil circuit breakers is for dividing feeders into sections and transferring the load from one line to another without interrupting the service.

Appreciating the demand for a simple but absolutely reliable outdoor type oil circuit breaker for moderate capacities and voltages, the Westinghouse Electric & Manufacturing Co. has placed on the market a modification of the type B breaker which has been successfully used as an indoor type for some years past.

This breaker has a separate tank for each pole, the tanks being made of welded seam boiler iron with an insulating lining, thus permitting an easy inspection of the contacts.

The breaker may be either automatic or nonautomatic in the tripping operation. The automatic tripping is effected by the use of current transformers located as an integral part of the circuit breaker, one transformer for a 2-pole breaker 3 for a 3-pole breaker, and 2 for a 4-pole breaker. This arrangement affords absolute protection under all conditions, and the use of less than 3 transformers for a 3-pole breaker is not advised.

The breaker is full automatic in its action; that is, cannot be held in closed position while a continued overload or short circuit exists on the line.

The outdoor hand-operated type breaker, as shown in the accompanying illustrations, is entirely self-contained, mounted on a substantial cast-iron frame that can be set in any location without foundation.

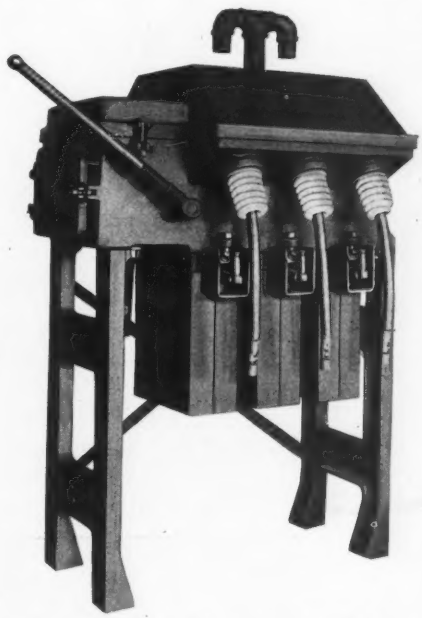


FIG. I. TYPE B OIL CIRCUIT BREAKER

The fact that each pole is enclosed in a separate tank renders the inspection of the contact mechanism easy.

The overload current transformers are mounted within the enclosing case of the breaker, thus being thoroughly protected from the weather and accidental contact with the operator. The leads from these transformers pass directly to the trip coils of the breaker, which are also enclosed in the housing.

Sight gages are supplied on each oil tank for determining the height of the oil, and the tank is filled with the oil through a plug located just above the sight gage.

Leads for indicating lamps that show the position of the contacts are brought out on the under side of

the case, and may be carried to any convenient location for the lamps.

A wooden closing bar is furnished, as shown in Fig. 2, for closing the breaker. This bar is inserted in the socket connected to the contact mechanism, as shown in Fig. 1, when it is desired to close the breaker, and then removed, the handle-socket serving as an indicator of the position of the contacts.

Vent pipe with a double opening is attached to the top of the weather-proof housing to permit the escape of gases arising at the time of the operation of the breaker under load.

The housing is so constructed that it can easily be removed, permitting a ready inspection of all parts of the breaker, at the same time, when assembled, it forms an entirely waterproof compartment.

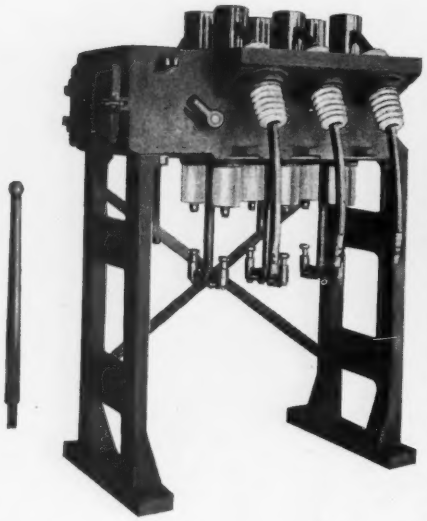


FIG. 2. OUTDOOR OIL CIRCUIT BREAKER WITH TANK REMOVED

Messrs. Wasserman and Co., of Lausanne, Switzerland, have discovered a process of brazing cast iron, especially for repairing castings. The substance employed is called "Castolin," and with this material it is claimed that a broken casting can be repaired on a smith's hearth or portable forge with no more difficulty than is caused by an ordinary brazing job.

MACDONALD SHAKING GRATES

THE Macdonald shaking grate made by the Robb Engineering Co., is so designed that the tilting of the sections improves combustion by giving maximum irregularity of surface for breaking up clinker and the mass of unburned fuel, yet does not open up wide spaces which would allow unburned coal to fall into the ash pit. The detachable top sections may be changed easily for altering air openings or for renewal at minimum expense. When in operating position the grate is flat, locked in place. The surface cannot be left uneven with points projecting into the fire for only when the grates are level can the lever be disengaged.

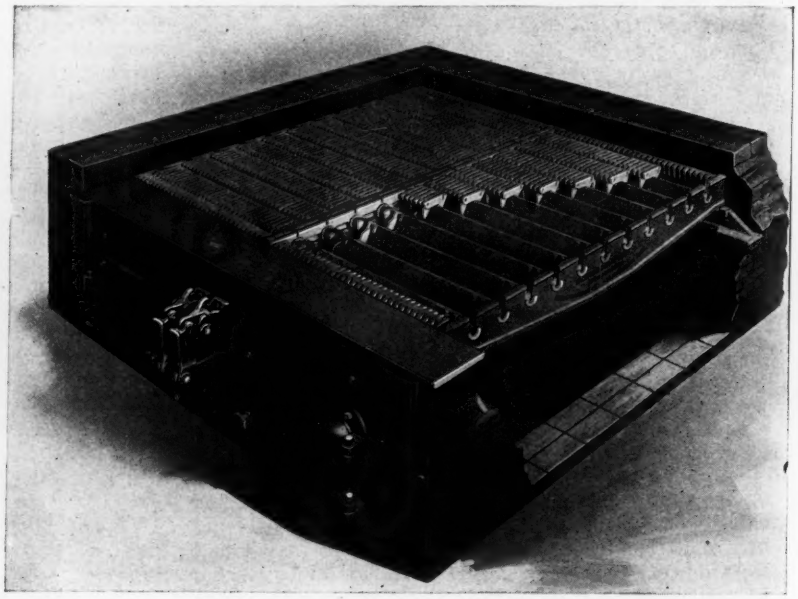


FIG. 1. MACDONALD SHAKING GRATE IN FLAT POSITION

To give great irregularity of surface in the Macdonald grates the points of the triangles are made to penetrate deeply into the body of the fire, allowing proper air circulation. The mechanism is so arranged that when the lever is operated the top surfaces of the triangular sections are 60 deg. from the horizontal, and the lever can be swung through an arc of about 60 deg. Because of the equilateral triangular construction of the sections and the fact that the tilting of

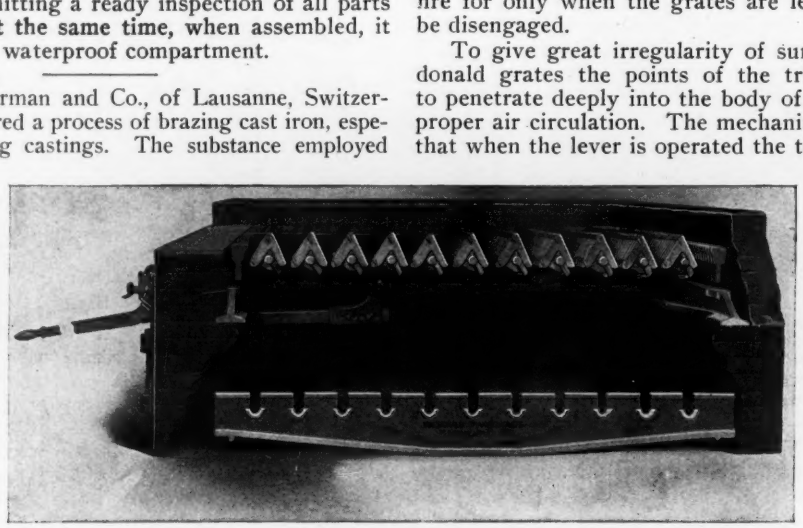


FIG. 2. DUMPING POSITION OF MACDONALD GRATE

the sections is entirely in one direction, the spaces between the grate sections at the end of the stroke are exactly the same as at the beginning, and during the whole movement there is practically no variation in the size of the spaces.

The Macdonald grates are made up of small, removable sections which securely fit the rocking bars. These sections can be furnished with any desired air space and can be replaced, when it is advisable to change the grade of coal used, without altering the rocking and supporting bars or operating mechanism. When necessary a few sections may be replaced without renewing the whole grate when perhaps only a small part is burned out. This design minimizes the cost of repairs and permits keeping the grates in their best working condition.

The locking device of the Macdonald grates does all the thinking for the operator, the grate being locked in a horizontal position cannot be moved until the shaking lever is inserted and locked in place, which movement unlocks the grate. Unlocking the bell crank so that the grates may be shaken, locks the operating lever, and the only position in which the cam may be thrown down so as to disengage the operating lever is when the grates are level.

These grates are adapted to any style of firebox, rectangular, circular, or the corrugated furnaces of internally-fired boilers.

THE PULSOMETER AS A POWER PLANT PUMP

IT seems rather peculiar that the pulsometer has been lost sight of, as it might be called the present day representative of the first type of engine successfully put into operation, since it works upon very nearly the same principle as the pumping engines designed and operated by Newcomen.

Figure 1 shows its internal construction. It consists of a hollow, one-piece casting having 2 bottle-shaped chambers AA, with their necks communicating at the top, and each opening into an outlet chamber O, through a check valve. An air chamber J connects with the suction inlet and serves to cushion the incoming pulsations.

Operation of the pump is as follows: Steam from the boiler is admitted at the top of the pump and enters either the right-hand or left-hand pumping chamber A, depending upon the position of the steam ball valve at the top. Assume that the left-hand pumping chamber is filled with water. The pressure of the steam depresses the surface of the water without agitation, forcing the water out through 2 check valves and into the discharge pipe H. The moment the water falls to the level leading to the discharge chamber, the even surface of the water is broken up, and owing to the peculiar design of the pumping chambers the water and steam are thoroughly churned up and brought into intimate contact, causing instant condensation of the steam. This forms a vacuum in the left-hand chamber, which, assisted by a slight upward pressure in the right-hand chamber, immediately pulls the steam valve over to the other seat shutting off the steam supply. The vacuum now draws in a new charge of water through the suction pipe. While this chamber is filling up, the right-hand is emptying by a process similar to that just mentioned. It will be seen that the action of pulsometer consists in alternately emptying and filling the pumping chambers. These operations continue as long as the pump is supplied with steam and water, the alternations following so rapidly and with such regularity, that the stream of water leaving the discharge pipe is practically continuous.

Each pumping chamber is provided with an inwardly opening air valve, which draws in a supply of air every time vacuum is formed in either chamber. This air forms a layer on top of the water, forming a sort of piston which keeps the water and steam from coming in contact too early in the operation, and also serves as a cushion to deaden the shock of the inrushing water.

One of the things that recommends the pulsometer for power plants is its simplicity. There are absolutely no mechanically operated parts, and the whole process

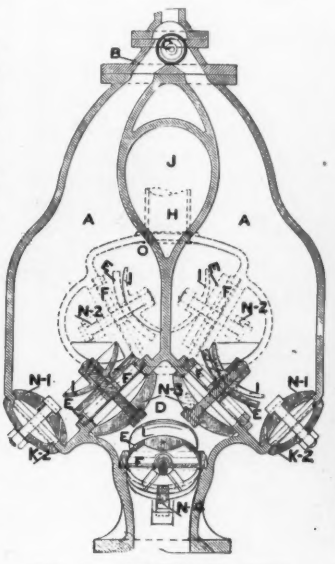


FIG. 1. SECTIONAL VIEW OF THE PULSOMETER

FIG. 2. THE PULSOMETER AS INSTALLED IN A POWER PLANT AS A SUMP PUMP

of emptying and filling the pumping chambers is entirely automatic. Furthermore, the pulsometer is light and inexpensive. It should also be noted that there are no rubbing contacts, therefore the pulsometer never needs lubrication, which is of special value where it is used as a sump pump, or handles water that is to go into the boiler.

It might be thought that the pulsometer is uneconomical in operation, but it has been proved that an average duty of 15-million ft.-lb. per 100 lb. of coal can be obtained and tests have shown a duty of over 23-million ft.-lb. When it is considered that the ordinary reciprocating pump very seldom shows a duty exceeding 15-million ft.-lb., it will be seen that the pulsometer compares favorably with this class of pump.

When the pulsometer is used as a sump pump, or for returning drips and other water to open heaters, it may be said to have a very high thermal efficiency, for all of the steam that is condensed in the pump is mixed with the water and returned again to the boiler feeding system, thus the only loss in heat is due to radiation.

Figure 2 shows a pulsometer permanently installed in the power plant of a large New York office building, where it is doing duty every day as a sump pump.

Another service for which pulsometers are frequently used is for sewage ejection in large office buildings and apartment houses. Here its cheapness and

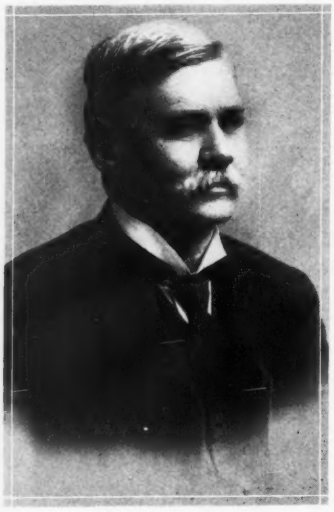
simplicity, and also the fact that it readily handles liquids containing a large proportion of solid matter recommend it highly. In other plants the pulsometer is used as a standby pump or relay.

The fact that the pulsometer needs no foundations, that it can be hung up from beams or suspended by a rope, has caused some engineers to have one around and use it for most any service that an emergency calls for.

The pulsometer is built in a number of sizes ranging from a delivery of 20 gal. per min. to 2000 gal. per min., and is manufactured by The Pulsometer Steam Pump Co., New York City.

DEATH OF JAMES M'BRIER

FOR many years, Mr. McBrier has been known as one of the most prominent men in the city of Erie, Pa., and has been intimately connected not only with the public welfare of that city, but with the development and improvement of the high-speed engine through his connection with the Ball Engine Works. Mr. McBrier went to Erie originally in 1872, in connection with the lumber business, afterward engaging in the lake shipping trade and finally locating permanently in Erie in 1887, when he became interested in the Ball Engine Co., of which he was made president, a position that he has held until the time of his death.



This company has been one of the foremost in the development and introduction of the high-speed engine, both in the single valve and 4-valve forms, and still continues as a leader in this field.

Mr. McBrier was a delightful man to meet, an energetic and successful manager in business, and with an integrity and straightforwardness which brought him many friends and gave him prominent position in the business and social organiaztions of his home city. He was prominently identified not only with the Ball Engine Works, but with the Erie Trust Co., First National Bank, Chamber of Commerce and Board of Trade, the Park Presbyterian Church, and was a member of the Masonic order and of the Erie and Kahkwa Clubs. His advanced age, which was 78 at the time of his death, has prevented his taking active part in the business of the company for some time, and this has been in charge of his 3 sons, David N., Harvey L. and Frederick, who, with 2 daughters, Mary L. and Mrs. Andrew Jarecki, survive him.

NEWS NOTES

DWIGHT T. ROBINSON and John W. Hallowell have become partners in the firm of Stone & Webster, Boston, Mass.

GEO. H. FROST, formerly proprietor of the Engineering News, has become a member of the Board of Directors of the Brown Portable Elevator Co., in conjunction with Messrs. Harwood Frost and Geo. W. Clark. The company manufactures portable elevators and conveyors for handling of materials in packages of any kind. It has a manufacturing plant at Portland, Ore., which will remain in charge of Fred H. Brown as heretofore; a new plant is to be built in the vicinity of Chicago as an eastern manufacturing center to replace a plant at Saginaw, Mich., which has been outgrown.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination on February 7-8, 1912, to secure eligibles from which to make certification to fill a vacancy in the position of skilled draftsman, at $1000 per annum, in the office of the Chief of Ordnance, War Department, and vacancies requiring similar qualifications as they may occur, at salaries ranging from $900 to $1200 per annum. The examination will be upon machine design and drafting, training, experience, and fitness will count for 35 per cent. Two days will be required for this examination, and the age limit is 18 years or over on the date of examination.

Under a recent act of Congress an applicant for this examination will be required to be examined in the state or territory in which he resides and to show that he has been actually domiciled in such state or territory for at least one year previous to the date of examination. Applicants should at once apply either to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners at any examination place for application Form 1312. No application will be accepted unless properly executed and filed with the Commission at Washington.

THE NEXT CONVENTION of the American Supply & Machinery Manufacturers' Association in conjunction with the National Supply & Machinery Manufacturers' Association and the Southern Supply & Machinery Dealers' Association, will be held in Norfolk, Va., May 13-15, with convention headquarters at Monticello Hotel. Arrangements have also been made with other hotels near the Monticello to accommodate those who cannot find room at headquarters. The other hotels available are the Lindhaven, Loraine, Fairfax and the Atlantic, and correspondence should be made with them direct for reservations.

THE 24TH ANNUAL CONVENTION of the American Boiler Manufacturers' Association, together with its associate members, and the Supplymen's Association, will be held in New Orleans, La., March 12 to 15, 1912, at which time some very important papers will be presented and other important business of interest to all the boiler manufacturesr in the United States and Canada, and Supply Houses dealing with the Boiler and Tank industry. An extensive programme of entertainment has been arranged, and a large attendance of boiler manufacturers and supplymen from the United States and Canada is expected to be in attendance. For information relative to rates, Hotel accommodations, etc., apply to F. B. Slocum, Continental Iron Works, Brooklyn, N. Y.

BOOK REVIEWS

METAL WORK AND ETCHING, by John D. Adams, 36 pages illustrated, 5 by 7 in., in cloth binding, price 25c postpaid, Chicago, 1911.

This is a manual for art metal workers, giving details for making, from sheet brass and copper by the etching and bending process, useful and ornamental objects, such as book ends, desk sets, paper knives, stationery racks, calendars, hinges, drawer pulls and so forth. The instructions are complete and easily followed and the designs given are attractive and artistic.

QUESTIONS AND ANSWERS FOR AUTOMOBILE STUDENTS AND MECHANICS, by Thos. H. Russell. Chicago, 1911, 140 pages, 5 by 7 in., in cloth binding, stiff covers, price, $1.

For those interested in learning to drive or care for an automobile, this book, containing 600 questions and answers, will be found helpful and interesting. The subjects treated are: Motor Cars, Engines, the Carbureter, Electricity, Ignition, Cooling Systems, Transmissions and Gearing, Tires, Troubles, Timing and Valve Setting, Motors and Mechanism, Driving the Car.

An advantageous arrangement is the method of putting the questions in numbered order in front of the answers. The answers are then numbered and put in a section by themselves following the questions, so that for those who do not wish to use the questions the book can be read straight on, without confusion, while for those who wish the question and answer method the numbering of questions and corresponding numbers to the answering paragraphs give all the advantage of the catechism arrangement.

HENDRICKS' COMMERCIAL REGISTER OF THE UNITED STATES. 1419 pages in cloth binding, 20th edition, price $10. For sale by S. E. Hendricks Co., 74 Lafayette St., New York.

This 20th revised edition is a most complete classified list of manufacturers covering architectural, engineering, electrical, mechanical and kindred trades and professions. The completeness of classification is shown by the fact that the total number is over 45,000, each representing the manufacturers of or dealers in some machine, tool, specialty or material required in the industries mentioned or kindred lines. It is completely indexed, 108 pages being required for this purpose. Classifications are simply and clearly arranged for use either in buying or selling, and in the 20th edition are numbered so that direct reference can be made to a classification without reference to the page number. As an illustration of the completeness, all manufacturers of a particular trade are first classified under a general heading for mailing purposes and then subdivided under as many classifications as every variety of product of a firm or corporation may call for. Trade names of articles classified are given so far as possible, being included in parenthesis between the names and addresses of the manufacturers. It is a book which cannot fail to be valuable in every office which has to do with engineering, railways, iron, or allied industries.

THE PRINCIPLES OF SCIENTIFIC MANAGEMENT, by Frederick W. Taylor, 6 by 9 in., 142 pages, cloth bound, $1.50.

This new book from the press of Harper & Bros., is Mr. Taylor's own statement of the principles of the science which he has worked out. For 30 years he has been laboring in Philadelphia and elsewhere on this system, and in this book he records his experiences and conclusions. He believes that the man is the main thing in industry because the labor cost is the chief item in production, and also that in the management of an industry attention should be fixed upon the contact of the man with his labor. Also that methods and standards of production should be determined by a scientific study of the man at his job. The progress of scientific management has been slow, but in many plants it has proved its value by increasing production as well as increasing the compensation of the workman. The luxuries and comforts which man can enjoy depend upon the surplus of labor after producing necessities, and a system which adds to production tends therefore to greater comfort and luxury for mankind. The book shows application to several industries as well as principles.

THE STORY OF BREAD. It may be questioned what this has to do with power plant engineering, but there isn't much question what it has to do with the individual power plant of the engineer. It's a story of what bread has meant to the world, and how it has been made available as the staple food. It's as interestingly told as any magazine article and is delightfully illustrated with charming marginal sketches which just fit the text. It's a short story which you can read during a noon hour, and you will enjoy ever bit of it. Every man who eats bread will find it interesting and it also has a note of inspiration which invigorates the spirit as much as good bread does the body. A copy can be had by sending a request to the International Harvester Co., of America, Harvester Bldg., Chicago, and we advise you to send the request.

PRACTICAL THERMODYNAMICS, by Forest E. Cardullo. 408 pages, 6 by 9 in. cloth binding, price $3.50.

In the treatment of this subject the use of mathematics is unavoidable, and it is necessary for the student to understand the use of algebra, the table of logarithms, and calculus, but the author has used a minimum of the higher mathematics and has, as a rule, explained the results derived by the use of calculus, so that the equations can be used by anyone familiar with algebra.

The title, Practical Thermodynamics, refers to the direct relation which the results derived from the science bear to the design and operation of power plant machinery. For instance, it is shown how the matter of adiabatic expansion and steam superheating have application in the calorimeter and the steam separator; how the computations on the steam engine cycle apply to the indicator card, how this cycle is affected by the kinds of valves used, and the different engine construction. The pressure and energy transformation in steam turbines is directly related to the thermodynamic discussion, also the action of both surface and jet condensers. It is a book which brings the subject of thermodynamics into close touch with the power plant and will therefore do much to improve the understanding of the importance of complying with the thermodynamic laws in order to get best results.

At the end of each chapter are problems which are of practical importance in power plant work and which show clearly the application of the facts and formulas derived. The applications taken up are steam engines, steam turbines, condensing apparatus, the steam boiler, boiler plant auxiliaries, cooling apparatus, hot air engines, the internal combustion engine, air compression, refrigeration, heating, ventilation, evaporation and drying. The relation of thermodynamic laws to each of these machines and processes is clearly discussed.

WOOD-WORKING FOR AMATEUR CRAFTSMEN, by Ira S. Griffith, 120 pp., 4 by 6 in. Chicago, 1911, Cloth, 25c.

A book designed to cover in detail all the processes of woodworking by single steps so that it is suitable for self instruction or for manual training courses. It is concise, complete and clearly written and illustrated. It is good.

ELECTRICIANS OPERATING AND TESTING MANUAL, by Horstmann & Tousley, 359 pages fully illustrated, 4 by 6.5 in., in full leather binding, price $1.50.

Many an engineer has spent a great deal of time hunting for information in regard to the daily operation of his machinery such as is readily found in this book. It treats the subject covered, not from the point of the designing engineer, or with the thought in mind of what might possibly happen in a plant, but from the standpoint of what does actually happen in everyday running and of methods for handling the machinery and making tests to insure that the plant is operated in the most economical manner. It starts out with the information necessary to understand how electrical machinery operates and why certain things happen, and from this goes on to explain the correct way to make sure that the right things happen instead of the wrong things.

In detail, the subjects covered in the first 9 chapters relate to the principles of electricity and magnetism, the principles of operation of dynamos and motors, and the different types of such machines for both direct and alternating current. Chapters 10, 11 and 12 deal with the operation of dynamos direct and alternating current, and of motors, both synchronous and polyphase induction. Connections of transformers, the care and handling of storage batteries, the use of arc lamps and incandescent lamps for lighting, and the economy to be secured from each type, instruments for testing and methods of making tests on motor efficiency, on light efficiency, and on transformers, take up the pages of chapters 13 to 19. In the remaining chapters of the book the subject of dynamo and motor troubles, the connections of recording wattmeters, rules for avoiding hazard from fire and to life, and the use of ground detectors and lightning arresters are considered. The book is not a description of the details of commercial machinery, but is a real manual telling how and why to take care of electrical apparatus. It is fully indexed so that the matter relating to any special subject may be quickly found.

ELECTROPLATING, by Henry C. Reetz. 100 pages, 5 by 7 in., cloth binding, price 25 cents.

The book is clear in its description and illustrations and treats of the electrical equipment required for this work, of the shop equipment, methods of plating with copper, nickel, silver and gold, and miscellaneous hints in regard to the making of molds, finishing up work, etc.

METAL STATISTICS: published by the American Metal Market and Daily Iron and Steel Report, New York; 208 pages, 3½x6 inches; bound in cloth.

The latest edition of this work contains a larger and better selection of statistical information relating to the metal and iron and steel trades, than any of the previous issues, and the figures are presented in such a clear and concise form, that it provides a very convenient and complete reference. It contains all the important statistics covering the production, consumption and price movements of all metal and iron and steel products for a series of years, and unusual care has been taken by the editors to include only such figures as have been proved reliable.

THE COPPER HANDBOOK, VOL. X. The tenth annual edition of the Copper Handbook is received. The new issue of this work, which is considered a standard authority on the subject of copper and copper mines for the entire globe, has 1902 pages 6 by 9 in., containing nearly 1,500,000 words, and, in addition to the miscellaneous chapters, lists and describes 8130 copper mines and copper mining companies, in all parts of the world, this being the largest number of titles ever listed by any work on mining. The descriptions range from 2 or 3 lines, in the case of dead companies, wherein reference is made to detailed descriptions in past volumes at the period of their activity, up to 21 pages in the case of the Anaconda mine, which yields ⅛ of all the copper made in the world.

The miscellaneous chapters of the book, 24 in number, treat the subject of copper from all possible viewpoints, there being chapters on the history, chemistry, mineralogy, metallurgy, brands and grades, alloys and substitutes for copper, with a full glossary, and a chapter of statistics ending the book that contains 40-odd tables, thoroughly covering copper production, consumption, movements, prices, dividends, etc. The Copper Handbook is sold on the unique plan adopted 9 years ago, the publisher sending the book by mail, prepaid, to any address ordered, without advance payment of any sort, and subject to return after a week's inspection. The price is $5 in a strong green buckram binding with silk headband and gilt top, or $7.50 in full library morocco. Anyone interested in copper, as a producer, consumer or investor in shares, would do well to write the author and publisher, Mr. Horace J. Stevens, Houghton, Michigan, ordering a copy of the new Copper Handbook sent prepaid, subject to approval.

HEAT, by J. Gordon Ogden, 115 pages, 4.5 by 6.5 in. in cloth binding, illustrated; price 25c. This is one of the Popular Mechanics handbooks, dealing with the phenomena of heat in easily understood language. It describes the nature of heat and how it is measured, how low temperatures are produced and some effects of low temperature, the production and uses of high temperature, the effect of high temperatures on the rare metals, how heat travels and the effects which it produces in expansion and contraction, energy, its storage in fuels and its release, the manufacture of artificial ice, and steam boilers and engines. It deals with the subject from a physical rather than an engineering standpoint, but will serve to clear up one's thought in regard to the nature of heat phenomena as seen in power plants.

CATALOG NOTES

THE KEYSTONE LUBRICATING CO., of 21st and Clearfield Sts., Philadelphia, is issuing very comprehensive treatises on the subject of Keystone Grease Lubrication. The bulletins are issued monthly. A very serviceable bulletin binder is also supplied; a set of bulletins with a binder, will be sent upon request to anyone interested in the subject of lubrication.

THE CLING-SURFACE CO., of Buffalo, N. Y., have gotten out a Calendar for the local associations of the N. A. S. E., but which, until the supply is exhausted, they will be very glad to mail to any individual member of the N. A. S. E. on receipt of request.

ARC VALVE TAPPET ROCK DRILLS are described in a 16 page, 6 by 9 bulletin Form 4204, issued by Ingersoll-Rand Co., 11 Broadway, New York City. This drill has an arc-shaped valve which is moved on a

circular seat by a rocking tappet, the sliding surfaces all being concentric with the rocker pin. The working pressure is on the back of the valve, forcing it to its seat. The valve is moved by the piston through an intermediate tappet or rocker. This tappet swings on a pin and extends slightly into the cylinder bore, where it is moved by beveled shoulders on the piston sliding under it. An arm on the tappet carries a spring and plunger engaging the valve. The positive quality of the valve movement in this drill renders it peculiarly useful when steam is used and when water of condensation is likely to be encountered. Catalog shows sectional views of drill and also gives list of duplicate parts, together with descriptive table of sizes and capacities.

HAMMER DRILLS is the title of a 12-page, 6 by 9, pamphlet Form No. 4016, issued by Ingersoll-Rand Co., 11 Broadway, New York City, descriptive of the "MC-22" Telescope Feed Hammer Drill. This drill is of the valveless type, in which the piston itself performs the valve functions by covering or uncovering ports, which control is forward-and-back movement. This tool is intended for stopping, raising, and to a limited extent, drifting. It is not recommended for steady work in holes at less than 20 deg. from the horizontal, because of the difficulty of cleaning such holes. The telescope feed of the "MC-22" is that designated by this company as the "reversed feed" in which the inner, or piston, tube is attached to the drill, and the outer or cylinder tube runs out under pressure. The advantage of this arrangement is that the hose is stationary, not turning with the drill; and the tool may be used on a tripod or column by clamping the outer feed cylinder to the mounting. Catalog shows several views of machine in section and also list of duplicate parts.

IN A BULLETIN which forms an advance chapter from the Mineral resources of the United States for 1910, E. W. Parker, Statistician of the United States Geological Survey, explains the reason why the cost of anthracite coal is likely to go higher rather than lower. Copy of the bulletin can be obtained from the Director of the Survey, Washington, D. C.

COALS AVAILABLE for the Manufacture of Illuminating Gas is the title of a bulletin issued by the Federal Bureau of Mines, and which contains the results of investigations carried out by the Pittsburgh Experiment Station of the Bureau. The bulletin shows how the substitution of low grade coals for the higher priced Pennsylvania gas coals, which have heretofore been used, will serve to lessen the drain on the high grade coal resources of the country and also will enable the gas companies to draw their supply from a greater range of fields. The bulletin may be obtained by applying to the director of the Bureau of Mines, Washington, D. C.

FROM THE MARION MACHINE, FDRY. & SUPPLY CO., of Marion, Ind., has been received an interesting booklet entitled Boiler Room Economy which explains the simple construction and the use of the Marion Rotary Soot Blower. It illustrates the application of these blowers to boilers, shows the details of the blower and gives the experience of those who have used them.

BULLETIN 104 from the Goulds Mfg. Co., of Seneca Falls, describes its double acting triplex piston pumps with capacities from 530 to 2270 gal. per minute at 75 lb. pressure, and from 175 to 1525 gal. per minute at 150 lb. pressure. It gives full details and illustrations.

ON ITS 1912 CALENDAR the Star Brass Mfg. Co. illustrates a number of its specialties including steam whistles, indicators, valves, steam gages and gage cocks. The calendar is printed in large figures that can easily be read across the engine room.

THE ASHTON VALVE CO. is distributing among its patrons a beautiful calendar for 1912 which displays a reproduction of Ye Olde Bridge at Claremont, N. H., in a border design of Ashton specialties.

GENERAL ELECTRIC CO. has just issued Bulletin 4685, which is a revision of a previous bulletin on Belt Driven Alternators. The alternators illustrated and described in this publication are of the revolving field type and range in capacity from 30 to 550 kw. The bulletin contains diminsion diagrams of the complete line.

BULLETIN 4804, recently issued by the General Electric Co., is a revision of the company's previous bulletin on Direct Connected Generating Sets. These sets, while originally designed to meet severe conditions of marine work, are also well adapted, and have been used extensively for both power and lighting in isolated plants, and as exciters for alternating current generators in central station work.

A PUBLICATION which should prove of interest to those connected with the manufacture of paper is Bulletin 4784, just issued by the General Electric Co., and devoted to Electric Drive in Pulp and Paper Mills. The advantages to be derived from the use of electric power in this industry are set forth in the bulletin, and descriptions of a number of important installations are also included.

BULLETIN 4785, recently issued by the General Electric Co., is devoted to the subject of Electric Drive in Wood Working Plants and the advantages to be derived from the use of electric motors in this industry. The bulletin illustrates and describes the electric motor as a part of wood boring machines, drills, jig saws, rip saws, band, circular and swing saws, planers, etc.

THERE IS A WELL recognized and growing demand for a compact, durable and reliable oil switch for use on exciters of modern voltages. In Bulletin 4809, recently issued by the General Electric Co., is described that company's switch which has been especially designed to meet the requirements of modern service of this nature. This switch is illustrated and described in considerable detail in the above bulletin.

BULLETIN 4807, recently issued by the General Electric Co., illustrates and describes panels designed for use in small or isolated plants containing but one generator. The bulletin describes panels of 2 sizes, 76 and 90 in., the only difference in the 2 sizes being that the larger panel contains the necessary apparatus for controlling a constant current transformer. The publication contains dimension and connection diagrams.

GENERAL ELECTRIC air compressors having piston displacements of from 15 to 100 cu. ft. per minute, are portable and were designed for use where the installation of a system of piping is not feasible. These sets are mounted upon 3-wheel trucks which can easily be moved from one place to another. A detailed description of these sets is given in Bulletin No. 4810.

THE GENERAL ELECTRIC CO. has just revised its bulletin on voltage regulators. This publication illustrates and describes regulators for controlling the generator voltage and also those for regulating the feeder voltage. There are reproductions of curves showing voltage with and without regulators installed.

FRANCE PACKING CO., of Tacony, Philadelphia, is sending out a large 12-page calendar which will be found covenient for office or engine room and will be sent free upon request.

THE NEW BULLETIN No. 58 of the Industrial Instrument Co., of Foxboro, Mass., is a large 8 by 12 booklet illustrating and describing the Industrial Dial Type Indicating Thermometers and the Improved Recording Thermometers which cover ranges from 25 to 800 deg. F. Copies of the bulletin may be had upon request.

IDEAL ENGINES, made by A. L. Ide & Sons, of Springfield, Ill., are described in bulletin 17. New features of this engine, such as the special design bearings, the solid steel crank shaft, disk pin and flange with guard ring, the special design of piston valve, and other interesting features, are fully described. It is an attractive book and one well worth reading.

BOILER TOOLS is an illustrated folder showing the Faessler octagonal sectional expanders, roller expanders, and flue cutting machine made by the J. Faessler Mfg. Co., Moberly, Mo.

SAFETY AS APPLIED to grinding wheels tells the story of what the Norton Emery Wheel Co., of Worcester, Mass., is doing to safeguard users of its product. It is an attractive book and one which will be found of great interest to those having occasion to use grinding wheels of any description.

ELECTRICAL INSTALLATION in the Detroit River Tunnel Plant, is the title of a new 12-page bulletin just issued by the Gould Storage Battery Co., of New York City. This bulletin describes the Gould battery and allied regulating apparatus by means of which current from the Detroit Edison Co.'s plant is made to pull Michigan Central trains through the new Detroit River Tunnel. The engineering in connection with this installation is unusual and of special interest to those having excessive peak loads. A copy may be obtained by asking for Bulletin 12.

UTILIZATION OF WASTE STEAM, published by Benj. F. Kelley & Son, of New York, tells of the uses of the Standard Water-Tube feed-water heater made by that company in transferring heat from exhaust steam to boiler-feed water. The catalog gives the details of construction of the feed-water heater and also of the Kelley grease extractor and purifier, and also shows how a heater should be installed in order to get best results.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

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